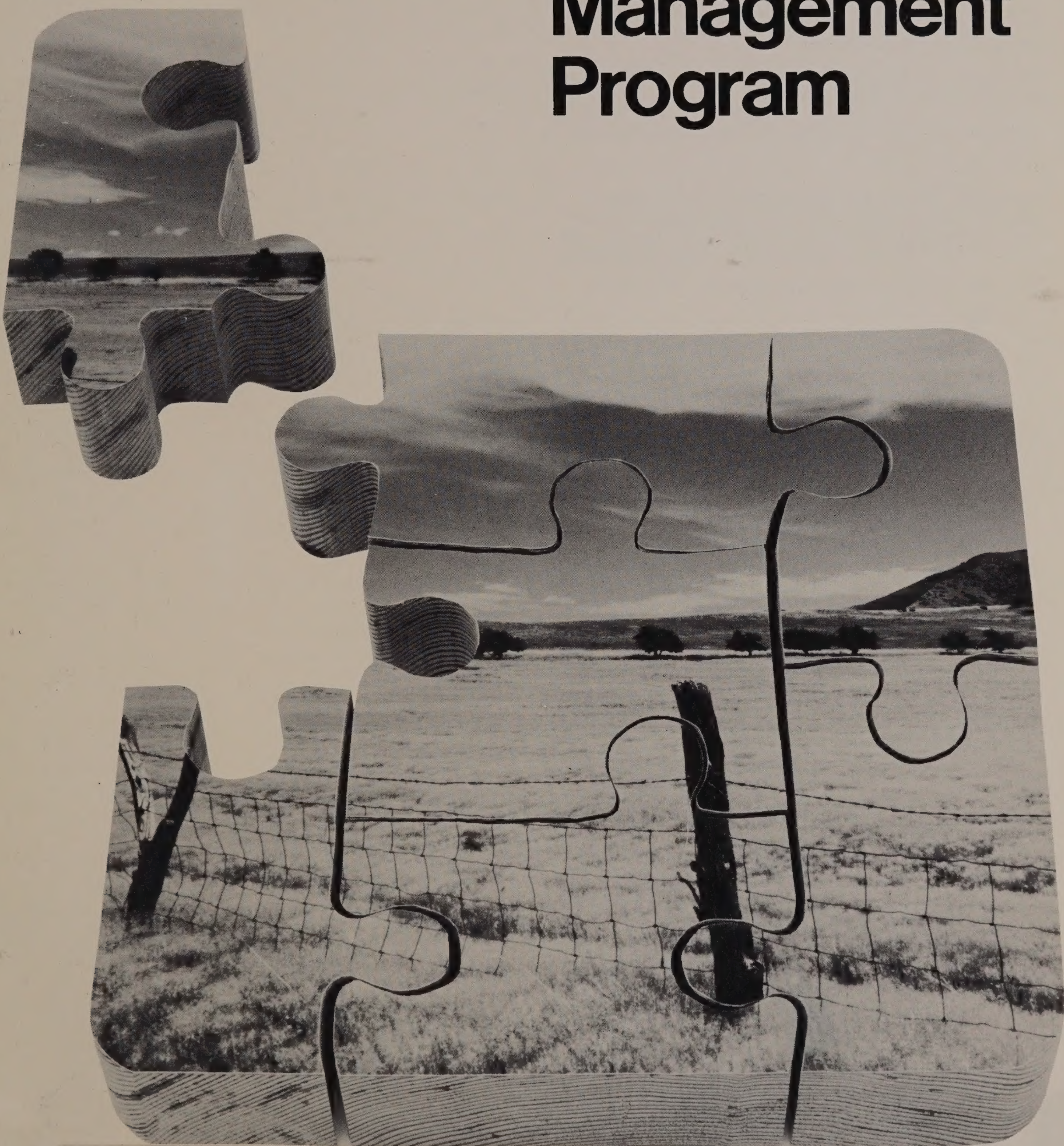
Visual Resource Management Program



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Contents


BLM Administered Lands
Outer Continental Shelf

Perspective

The quality of the visual environment has become increasingly important to the American public. The Bureau of Land Management is committed to managing visual resources on an equal basis with all other resources as it continues to put public land to productive use.

Visual Resource Management (VRM) has dual program purposes: to manage the quality of the visual environment, and to reduce the visual impact of development activities, while maintaining effectiveness in all Bureau resource programs. VRM also identifies scenic areas that warrant protection through special management attention. It is a specific process that can be mapped and incorporated into design planning for projects ranging from siting transmission lines to harvesting timber.

This publication is an introduction to the VRM program. Its intended use is to familiarize decision makers, land use planners, and designers both inside and outside of the Bureau with VRM and its benefits.

New Directions

Managing the visual aspects of changes to the natural landscape is particularly important for the Bureau of Land Management because most activities taking place on Bureau lands involve some degree of alteration. The Bureau's responsibilities for visual management are spelled out in key passages of recent Federal legislation.

The Federal Land Policy and Management Act of 1976 (FLPMA), often referred to as the "organic" act for the Bureau, requires that:

> public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archaeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use, . . .

The act also states that the Secretary of the Interior shall:

> prepare and maintain on a continuing basis an inventory of all public lands and their resource and other values (including but not limited to outdoor recreation and scenic values).

The Act, for the first time, places *scenic* resources on an equal basis with other resources. It also makes inventorying and managing scenic and other environmental values an explicit criterion that must be applied throughout the land management activities of the Bureau.

This same law also places new emphasis on the role of land use planning by requiring that resource management plans:

> give priority to the designation and protection of areas of critical environmental concern. The

criteria for identifying these areas are stated in the definition section: ". . . areas . . . where special management attention is required . . . to protect and prevent irreparable damage to important historical, cultural, or scenic values, fish and wildlife resources or other natural systems or processes or to protect life and safety from natural hazards."

The National Environmental Policy Act of 1969 (NEPA), an earlier and very important piece of environmental legislation, states that it is the Federal Government's responsibility to:

> assure for all Americans safe, healthy, productive, and aesthetically and culturally pleasing surroundings.

The Act further says that:

> all agencies of the Federal Government shall . . . identify and develop methods and procedures . . . which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations.

It also requires:

> a systematic and interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and decision-making which may have an impact on man's environment.

Significant aspects of these Federal laws are their increased emphasis on environmental and scenic values and their requirement that the long-term and short-term consequences of all resource commitments receive equal consideration.

The Bureau and Land Management

America's public lands and their resources have always been a public trust, but the management role of the Federal Government has changed with the times. After creation of the "Public Domain," when lands west of the Allegheny Mountains were transferred to Federal administration early in the nineteenth century, the government assumed responsibility for the protection and use of public lands. Hundreds of laws and grants were subsequently enacted to transfer ownership of these lands to homesteaders and other private parties. In the mid-1930s, however, the emphasis changed. Since that time, concepts for controlled management of the remaining public land (about 20 percent of the land area of the United States) have gradually evolved.

Over time, a number of public agencies have been created to oversee and manage public lands. One of these, the Bureau of Land Management, was established in 1946 and given responsibility primarily for the large grazing lands of the West. That stewardship has been expanded until now the Bureau bears responsibility for the total management of over 400 million acres of public land in the Far West, Alaska, and small areas scattered through the rest of the Nation. In addition, the Bureau manages an estimated 7 million acres of property on the Outer Continental Shelf. The Bureau's varied land management programs concern themselves with energy sources such as oil and gas, with timber, wildlife, and grazing activities, and with the cultural sites and recreation areas located on public land. In 1977, revenues from these lands and resources totalled more than $3 billion. These funds were derived from mineral leasing, land and timber sales, and other license, fee, and permit programs administered by the Bureau.

By Congressional mandate, management of the resources of these varied lands for *multiple use* and *sustained yield* is a major part of the Bureau's responsibility. *Multiple use* involves balancing the development of diverse resources, both renewable and non-renewable. *Sustained yield* involves coordinating the management of these resources so that environmental quality and the productivity of the

land are not permanently impaired. Managing vast and varied resources under this mandate is a complex undertaking, particularly since the priorities set for one management activity often conflict with the priorities set for another.

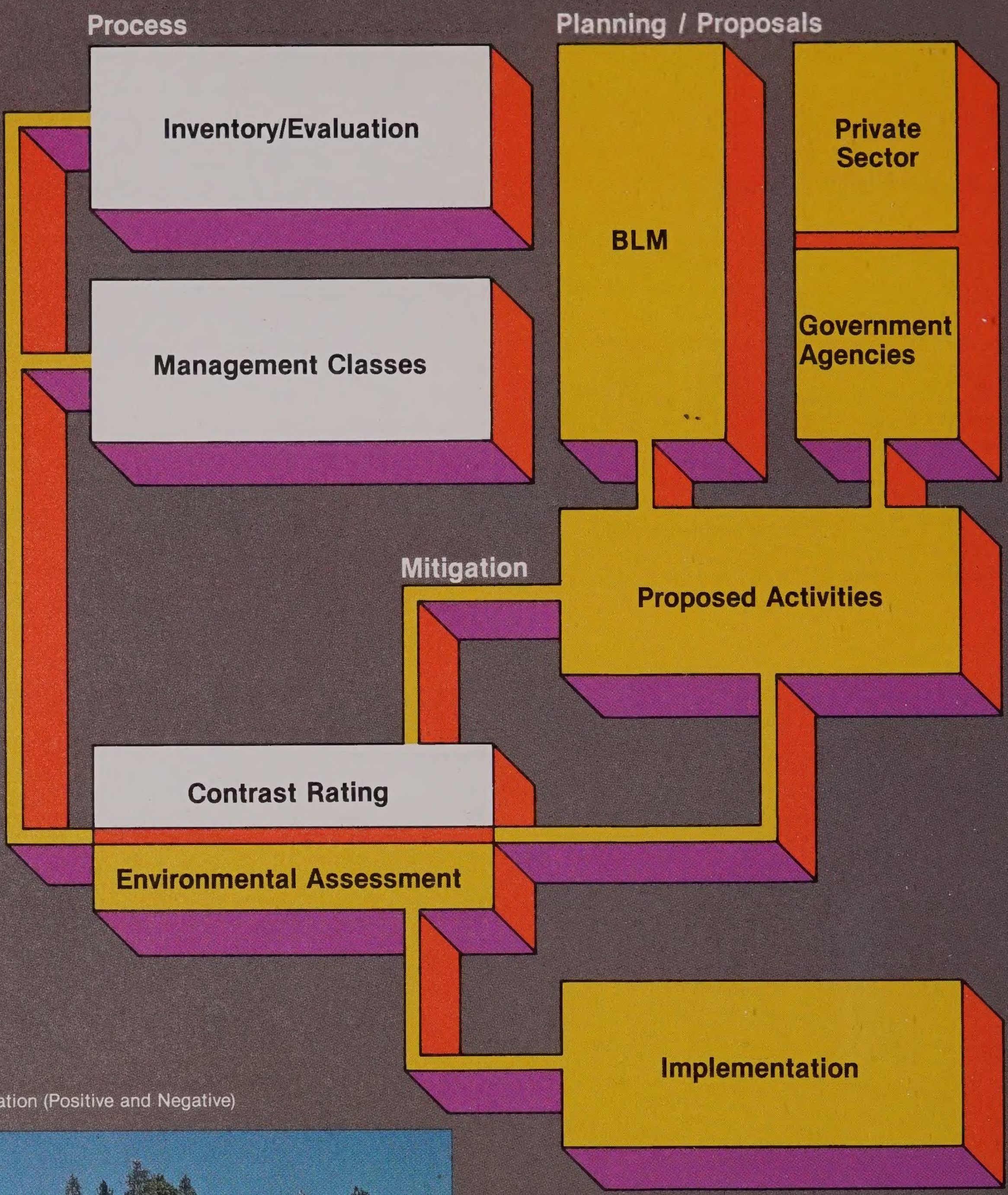
The Bureau and Visual Resources

The Bureau of Land Management is concerned with managing visual resources equally with other resources and attaining acceptable levels of visual impact without unduly reducing commodity production or limiting overall program effectiveness. It is therefore Bureau policy that visual resource considerations be included in environmental assessments, in land use planning decisions, and in the implementation of resource projects.

Since it was put into effect in 1975, the VRM program has helped set standards for transmission line location, timber harvesting, recreation development, range management, mining activities, and highway placement.

Because the scenic value and management objectives of public lands vary, it is not practical to provide a uniform level of visual management for all areas administered by the Bureau. The agency has therefore developed a system for evaluating the visual resources of a given area and for determining what degree of protection, rehabilitation, or enhancement is desirable and possible. This Bureau-wide system provides an inter-disciplinary approach to managing visual resources. The integration of VRM into the Bureau's procedures for planning and environmental analysis ensures maximum coordination between a proposed land use and the existing visual conditions.

System



Cultural Modification (Positive and Negative)

Concepts

The VRM system is an analytical process that identifies, sets, and meets objectives for maintaining scenic values and visual quality.

The system is based on research that has produced ways of assessing aesthetic qualities of the landscape in objective terms. What had been considered extremely subjective (aesthetic judgment, particularly concerning the landscape) was found to have identifiable, consistent qualities that can be described and measured. Whatever the terrain (and whoever the observer), perception of visual quality in a landscape seems to be based on several common principles:

- Landscape character is primarily determined by the four basic visual elements of *form, line, color, texture.* Although all four elements are present in every landscape, they exert varying degrees of influence.
- The stronger the influence exerted by these elements, the more interesting the landscape.
- The more visual variety in a landscape, the more aesthetically pleasing the landscape. Variety without harmony, however, is unattractive, particularly in terms of alterations (cultural modifications) that are made without care.

The Bureau incorporates these and other principles in its broad program for managing visual resources.

The VRM system functions in two ways.

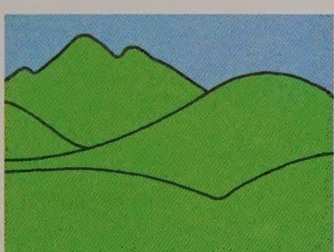
First, for management purposes, the Bureau conducts an inventory that evaluates visual resources on all lands under its jurisdiction (**Inventory/Evaluation**). Once inventoried and analyzed, lands are given relative visual ratings (Management Classification). The development of Management Classes is not project-specific. It is a general process to identify broad visual objectives for all public lands.

Second, when development is proposed, by the Bureau itself (through its planning process), or by other agencies or the private sector, the degree of contrast between the proposed activity and the existing landscape is measured (**Contrast Rating**).

These combined steps constitute the VRM process, which has a number of applications. The process can help make the visual impact of proposed activities more acceptable while these activities are still in the design stage. Graphic simulations of proposed activities help illustrate the extent of potential visual impact. Modifications may be suggested. During project construction, monitoring assesses actual visual impact. In both instances, VRM plays a support role.

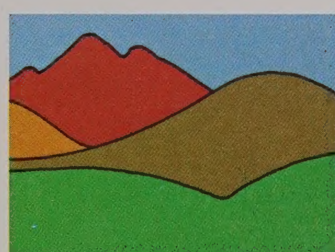
VRM also functions in close conjunction with two other key Bureau programs: **Land Use Planning**, which affects nearly every resource decision, and **Environmental Assessment**, which is required in proposals made for projects on BLM managed lands. The flexibility of VRM allows it to be easily incorporated into these current decision-making processes as well as into those that may be developed in the future.

Form

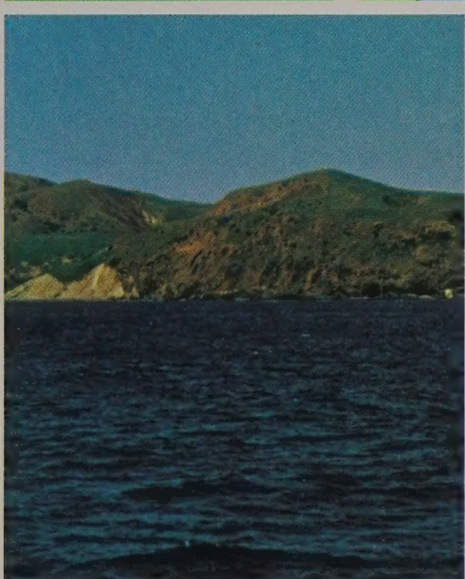


Line

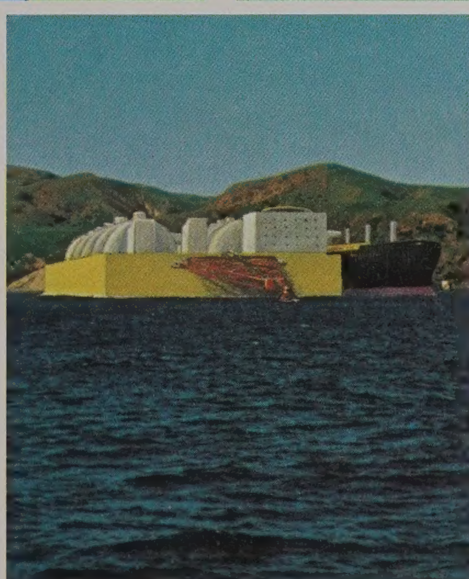
Color



Texture



Proposed Site



Simulated Activity

Monitoring by Satellite Imagery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7
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4

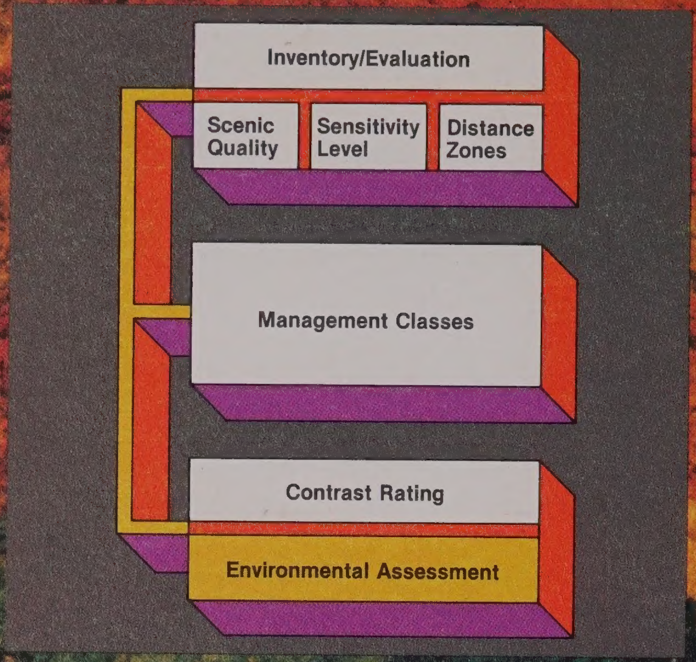
Terms

To understand how the Bureau of Land Management manages visual resources, it is important to understand how some key terms are used in the VRM system.

Many of the terms illustrated and briefly defined here are drawn directly from the visual arts. Others have been modified somewhat, given special meanings by their VRM context. All are basic—the "program language" of VRM.

1	**Form**	The mass or shape of an object, which appears unified; often defined by edge, outline, and surrounding space.
2	**Line**	The path that the eye follows when perceiving abrupt differences in form, color, or texture. In the landscape, ridges, skylines, structures, changes in vegetation, or individual trees and branches may be perceived as line.
3	**Color**	The property of reflecting light of a particular wavelength that enables the eye to differentiate otherwise indistinguishable objects.
4	**Texture**	The visual manifestation of the interplay of light and shadow created by variations in the surface of an object.
5	**Harmony**	The combination of parts into a pleasing or orderly whole; congruity; a state of agreement or proportionate arrangement of form, line, color, and texture.
6	**Variety**	The condition of having differentiated parts; the absence of monotony or sameness.
7	**Contrast**	The effect of a striking difference in form, line, color, or texture of a landscape's features.
8	**Cultural Modification**	Any man-made change in land, waterform or vegetation (roads, bridges, buildings, fences); the addition of a structure which creates a visual contrast to the natural character of a landscape. A *negative* cultural modification is disharmonious with the existing scenery. A *positive* cultural modification can actually complement and improve a particular scene by adding variety and harmony.
9	**Back Lighting**	The light source comes from behind the object viewed. The visible face of the object is generally in shadow and its edge highlighted.
10	**Front Lighting**	The light source comes from behind the observer and falls directly on the object viewed. There is little shadow effect.
11	**Side Lighting**	The light source comes from one side of the object viewed. This is the light considered most effective for evaluating visual contrast.

Process


Inventory/Evaluation
Scenic Quality
Sensitivity Level
Distance Zones
Management Classes
Contrast Rating
Environmental Assessment

Inventory/Evaluation

The Inventory/Evaluation process in the VRM consists of three steps: assessment of the visual quality of the landscape, the sensitivity of the people to change(s) in the landscape, and the viewing distance. Although the details of the evaluation are intricate, the process itself is straightforward.

Scenic Quality

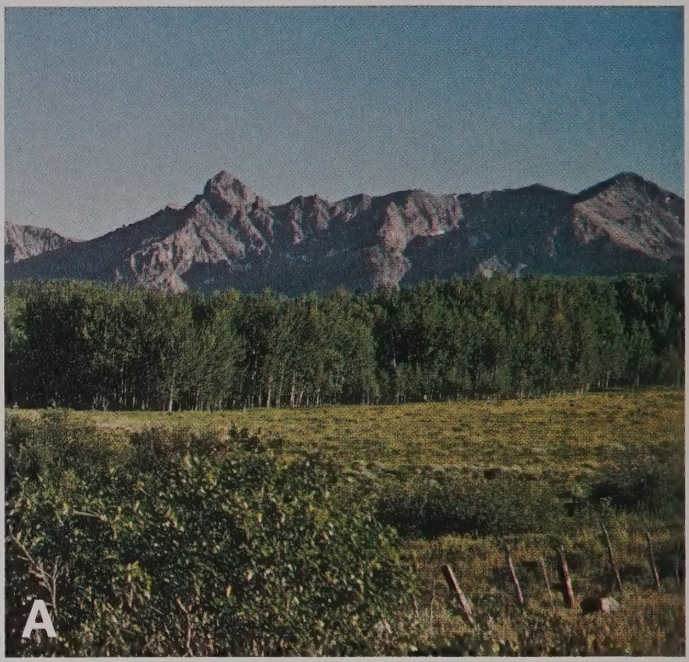
Scenic Quality is perhaps best described as the overall impression retained after driving through, walking through, or flying over an area of land. In the VRM process, rating Scenic Quality requires a brief description of the existing scenic values in a landscape. This step identifies (1) areas that must be protected, (2) opportunities for enhancement and rehabilitation, and (3) opportunities for improvement by reducing the contrast of cultural modifications.

When inventoried, an area is first divided into subunits that appear homogeneous, generally in terms of landform and vegetation. Each area is then rated by seven Key Factors: *landform, vegetation, water, color, influence of adjacent scenery, scarcity,* and *cultural modification.* A standardized point system assigns great, some, or little importance to each factor. The values for each category are calculated and, according to total points, three Scenic Quality Classes are determined and mapped:

Class A Areas that combine the most outstanding characteristics of each rating factor (*19-33 points*).

Class B Areas in which there is a combination of some outstanding features and some that are fairly common to the physiographic region (*12-18 points*).

Class C Areas in which the features are fairly common to the physiographic region (*0-11 points*).


A


B


C

Scenic Quality Inventory/Evaluation Rating Criteria and Score

Landform	Vegetation	Water	Color	Adjacent Scenery	Scarcity	Cultural Modifications
High vertical relief such as prominent cliffs, spires or massive rock outcrops; **or** severe surface variation or highly eroded formations including major badlands or dune systems; **or** detail features dominant and exceptionally striking and intriguing such as glaciers. **5**	A variety of vegetative types in interesting forms, textures, and patterns **5**	Clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. **5**	Rich color combinations, variety or vivid color; **or** pleasing contrasts in the soil, rock, vegetation, water or snow fields. **5**	Adjacent scenery greatly enhances visual quality. **5**	One of a kind; **or** unusually memorable; **or** very rare within region. Consistent chance for exceptional wildlife or wildflower viewing. **6**	Free from esthetically undesirable or discordant sights and influences; **or** modifications add favorably to visual variety. **2**
Steep canyons, mesas, buttes, cinder cones and drumlins; **or** interesting erosional patterns or variety in size and shape of landforms; **or** detail features present and interesting though not dominant or exceptional. **3**	Some variety of vegetation, but only one or two types. **3**	Flowing or still, but not dominant in the landscape. **3**	Some intensity or variety in colors and contrast of the soil, rock and vegetation, but not a dominant scenic element. **3**	Adjacent scenery moderately enhances overall visual quality. **3**	Distinctive, though somewhat similar to others within the region. **2**	Scenic quality is somewhat depreciated by inharmonious intrusions, but not so extensively that they are entirely negated; **or** modifications add little or no visual variety to the area. **0**
Low, rolling hills, foothills **or** flat valley bottoms. Interesting, detailed landscape features few or lacking. **1**	Little or no variety or contrast in vegetation. **1**	Absent, or not noticeable. **0**	Subtle color variations, contrast or interest; generally muted tones. **1**	Adjacent scenery has little or no influence on overall visual quality. **0**	Interesting within its setting, but fairly common within the region. **1**	Modifications are so extensive that scenic qualities are mostly nullified or substantially reduced. **-4**

Sensitivity Levels

Although landscapes do have common elements that can be measured, there is obviously still a subjective dimension to landscape aesthetics. Each viewer brings perceptions formed by individual influences: culture, visual training, familiarity with local geography, personal values.

To measure regional and individual attitudes in the evaluation of a landscape, visual sensitivity is determined in two ways:

Use Volume Frequency of travel through an area (by road, trail, river) and use of that area (for recreation, camping, events) are tabulated. The area is then assigned a *high, medium,* or *low* rating according to predetermined classifications.

User or Public Reaction Public groups are familiarized with the area (if necessary) and asked to respond to activities that will modify that landscape. The concern they express about proposed changes in scenic quality is also rated *high, medium,* or *low.*

The various combinations of Use Volume and User Reaction for each area are rated by a matrix to an overall Sensitivity Rating of *high, medium,* or *low.* A map is then developed that illustrates final Sensitivity Levels.

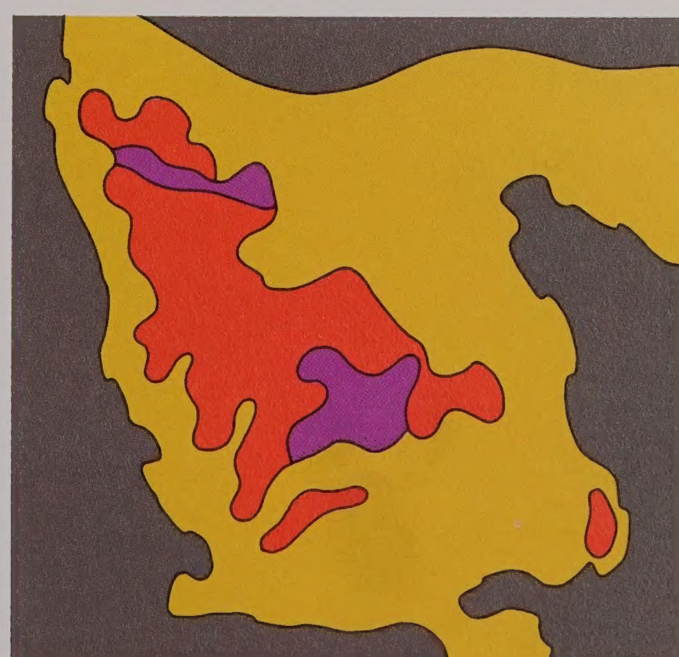
Sensitivity Level Matrix

Sensitivity	High				Medium			Low	
User Attitude	H	H	M	H	L	M	M	L	L
Use Volume	H	M	H	L	H	M	L	M	L

User Attitude
High
Medium
Low

Use Volume
High
Medium
Low

Final Sensitivity
High
Medium
Low



Distance Zones

The visual quality of a landscape (and user reaction) may be magnified or diminished by the visibility of the landscape from major viewing routes and key observation points. In the VRM system, thus, distance plays a key part in visual quality management.

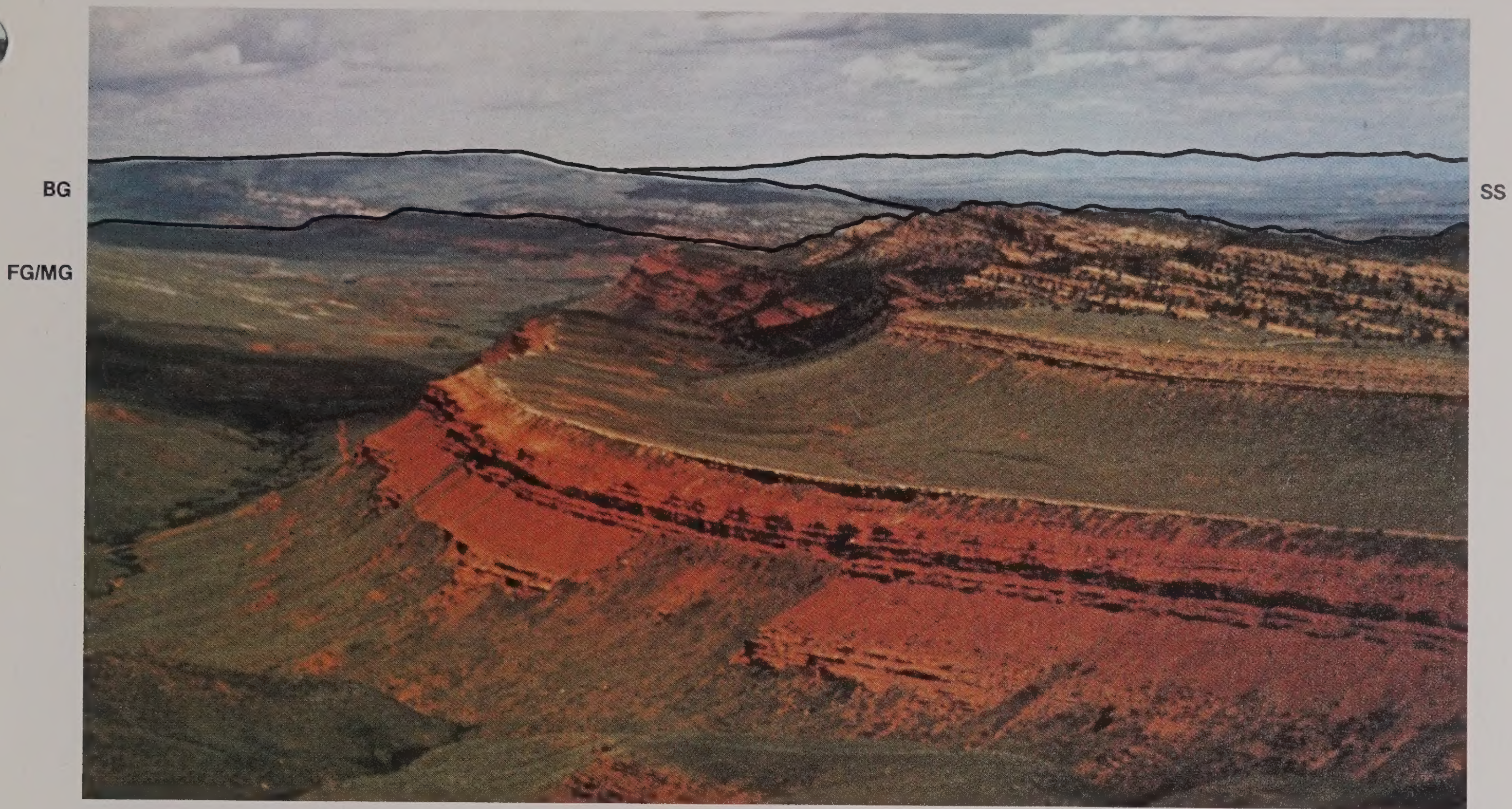
A landscape scene can be divided into three basic Distance Zones: **foreground/middleground, background,** and **seldom-seen.** Because areas that are closer have a greater effect on the observer, such areas require more attention than do areas that are farther away. Distance Zones allow this consideration of the proximity of the observer to the landscape.

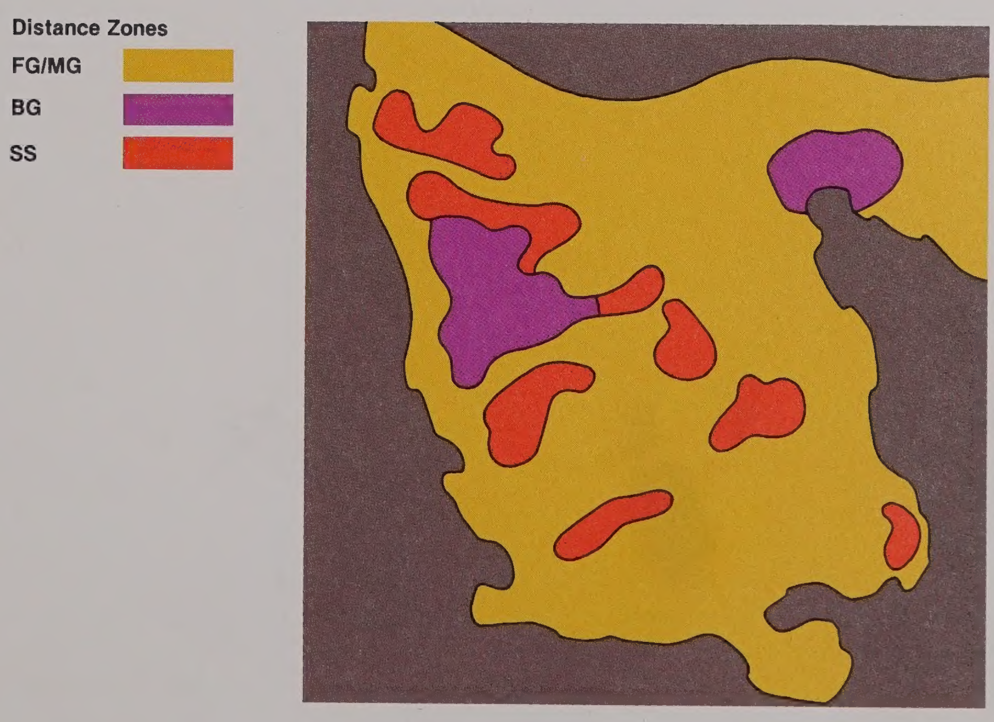
Selection of the key viewing points and accurate assessment of Distance Zones require some judgment. Where several routes exist, what is foreground from one route may be background from another. (The more restrictive designation is used.) Atmospheric conditions may also modify the perception of distance.

For small projects, in-field photographic assessment of Distance Zones is usually sufficient. For large projects, however, or projects that require evaluation from many key viewpoints, an alternative method for generating data is to use a computer graphic modeling technique such as the VIEWIT system.

The process culminates in the preparation of a final Distance Zone map.

Distance Zones Example





Management Classes

Management Classes describe the different degrees of modification allowed to the basic elements of the landscape. Class designations are derived from an overlay technique that combines the maps of Scenic Quality, Sensitivity Levels and Distance Zones. The overlays are used to identify areas with similar combinations of factors. These areas are assigned to one of five Management Classes according to predetermined criteria. The resulting map of contiguous areas sharing the same VRM class is an important document for all Bureau land use planning decisions, and it is also used to assess the visual impact of proposed development.

Management Classes

- Class 1
- Class 2
- Class 3
- Class 4
- Class 5

Visual Sensitivity	H			M			L
Special Areas	1	1	1	1	1	1	1
Scenic Quality A	2	2	2	2	2	2	2
B	2	3	3	3	4	4	4
C	3	4	4	4	4	4	4
Distance Zones	FG MG	BG	SS	FG MG	BG	SS	SS

Note: Class 5 areas are those that have been identified in the VRM planning system which require rehabilitation or enhancement and therefore are not included in this chart.

Class 1

Natural ecological changes and very limited management activity are allowed. Any contrast created within the characteristic landscape must not attract attention. This classification is applied to wilderness areas, wild and scenic rivers, and other similar situations.

Class 2

Changes in any of the basic elements (form, line, color, texture) caused by a management activity should not be evident in the characteristic landscape. Contrasts are seen, but must not attract attention.

Class 3

Contrasts to the basic elements caused by a management activity are evident, but should remain subordinate to the existing landscape.

Class 4

Any contrast attracts attention and is a dominant feature of the landscape in terms of scale, but it should repeat the form, line, color, and texture of the characteristic landscape.

Class 5

The classification is applied to areas where the natural character of the landscape has been disturbed to a point where rehabilitation is needed to bring it up to one of the four other classifications. The classification also applies to areas where there is potential to increase the landscape's visual quality. It would, for example, be applied to areas where unacceptable cultural modification has lowered scenic quality; it is often used as an interim classification until objectives of another class can be reached.

Contrast Rating

To evaluate specific proposed projects, a Contrast Rating System is used to measure the degree of contrast between the proposed activity and the existing landscape. This score is compared with allowable levels of contrast for the appropriate Management Class. The comparison will determine if mitigation is required to reduce visual impacts.

The process first segregates a landscape into its major **features** (*land/water surface, vegetation, structures*) and each feature, in turn, into its basic **elements** (*form, line, color, texture*). Each element is assigned a weighted value based on its significance in the landscape (*form* = 4, most important, to *texture* = 1, least important).

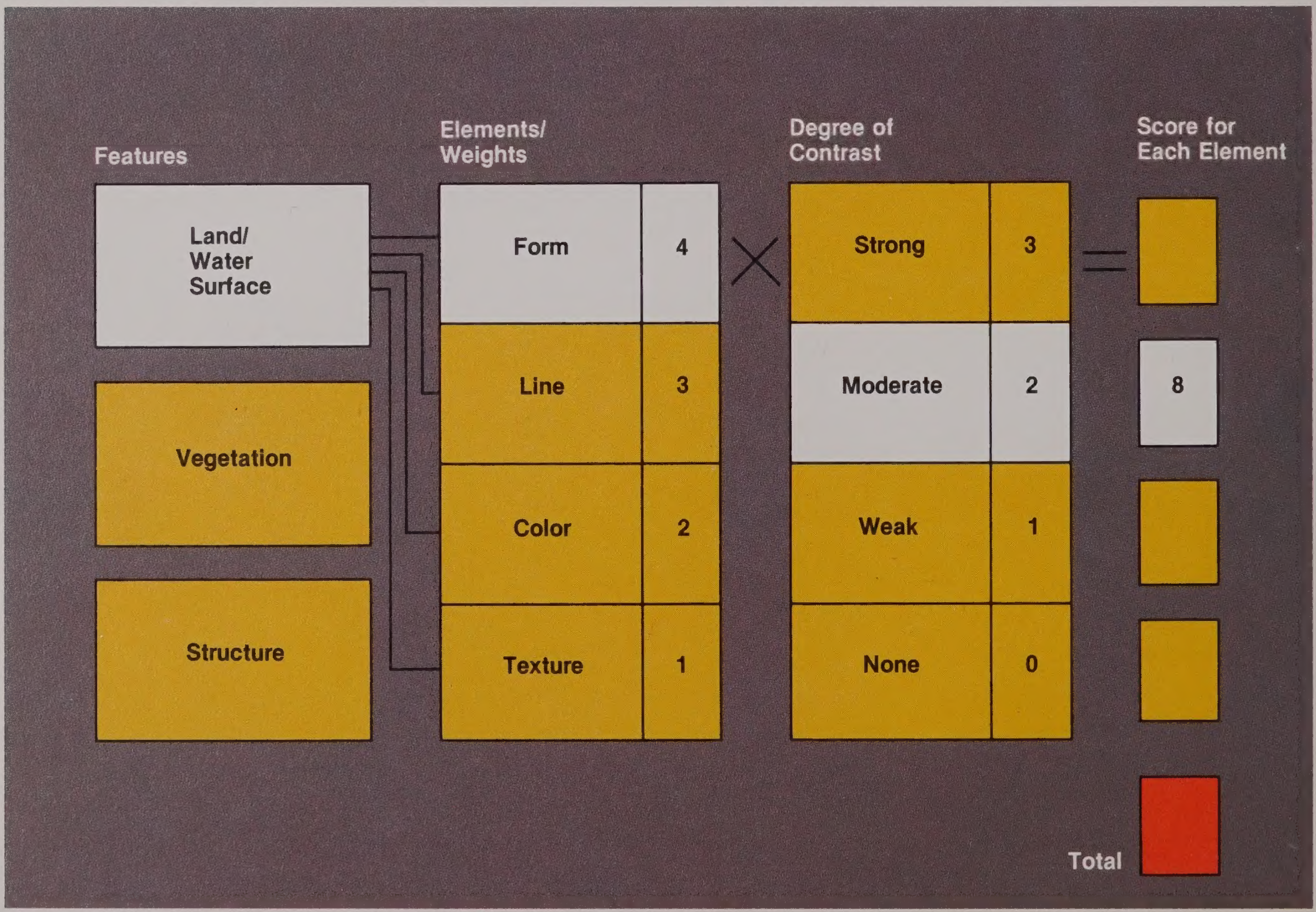
The Contrast Rating compares the proposed activity with existing conditions element by element, feature by feature, according to the degree of **contrast** (3 = *strong*, 2 = *moderate*, 1 = *weak*, 0 = *none*). The element value multiplied by the degree of contrast indicates the magnitude of visual impact. For example, the *form* (4) of a proposed water tank might have a *moderate* (2) contrast with a flat landscape. Therefore, the *form* category of *land/water surfaces* would produce a Contrast Rating of 8 (4x2).

The Contrast Rating quickly reveals the existing features and their respective elements that will be subject to the greatest visual impact. A total contrast score for each feature may then be used to define the overall contrast according to the following general categories:

- Contrast can be seen but does not attract attention *(0-10 points).*
- Attracts attention and begins to dominate *(11-20 points).*
- Demands attention and will not be overlooked by the average observer *(21-30 points).*

This score is then compared to the appropriate Management Class to determine if contrast totals are acceptable. If the proposed project exceeds the allowable contrast, then a Bureau decision is made to (1) redesign, (2) abandon or reject, or (3) proceed, but with mitigation measures stipulated to reduce critical impacts.

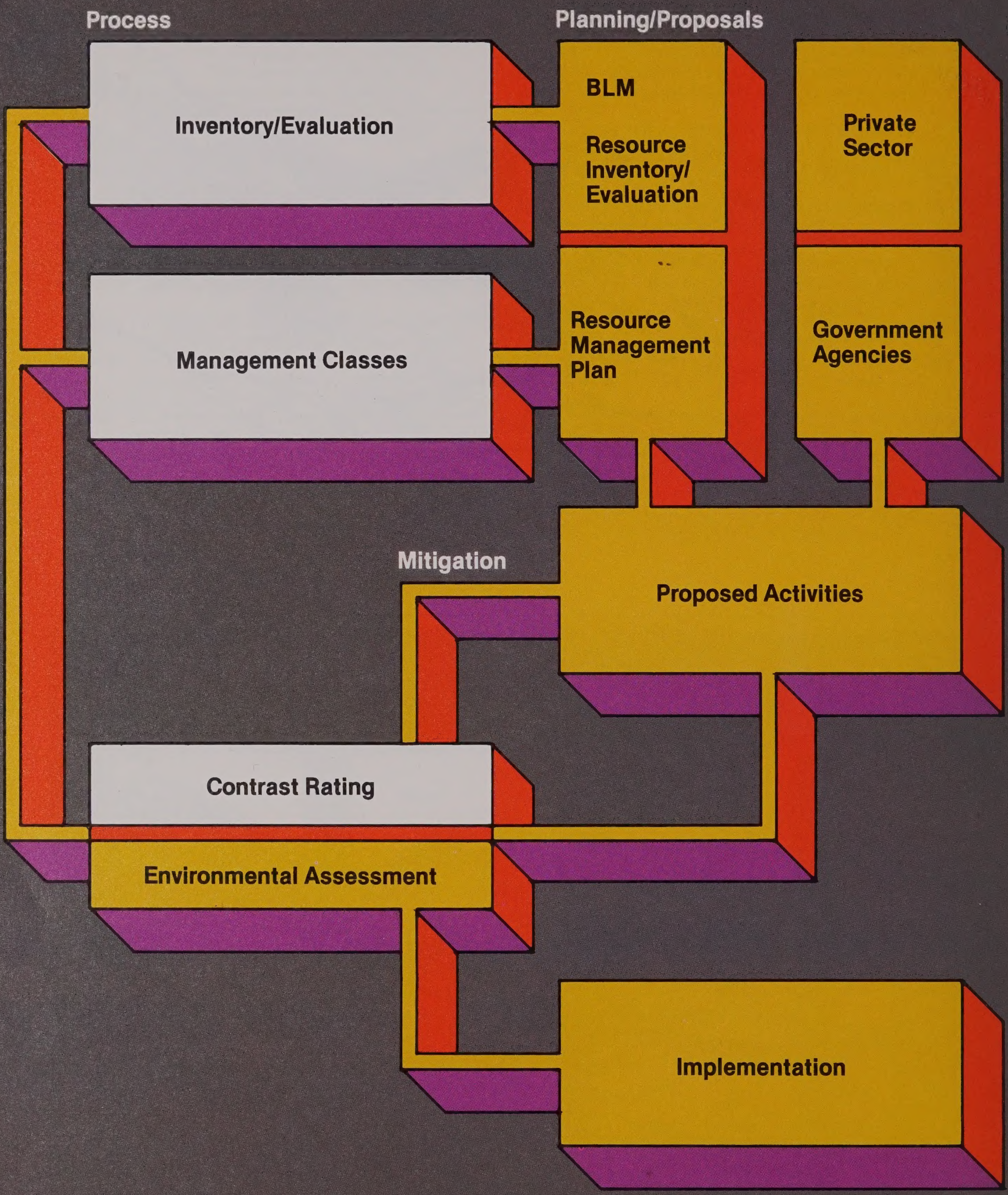
Since each activity proposed for Bureau administered land must pass through this evaluation, it has proven useful to identify and mitigate extreme contrasts to scenic quality in the planning/design stage of a proposed activity prior to submittal for approval. This pre-evaluation can save time and money because it forestalls a potentially lengthy revision process.



Proposed Site

Simulated Activity

Integration



Land Use Planning

Because there are such diverse factors affecting the management of public lands, proper planning is essential. The Bureau bases its management decisions on an extensive land use planning process.

This systematic process, which now includes careful consideration of visual resources, moves from the examination of existing conditions at a local scale through the formulation of cumulative land use plans and comprehensive decisions on a regional basis.

The basic building block of the Bureau's multiple-use planning is the Planning Unit. Resource inventory data, planning decisions, and other relevant facts are recorded for these units. A Planning Area contains one or more contiguous Planning Units. There are typically several Planning Areas in a District, and several Districts in a State. Each District is the responsibility of a District Manager who oversees planning, implementation and overall operation for each Planning Area.

As part of its planning process, the Bureau prepares numerous documents. These include documents which summarize Resource Inventory and Evaluation data, past planning decisions, and other relevant facts for the Planning Unit. They analyze the unit's potential to fill public needs for minerals, recreation, wildlife, forest, and rangeland.

In addition, another document uses socio-economic information to evaluate the present and future needs for land and for both renewable and non-renewable resources.

The Bureau then evolves its land use plan—the Resource Management Plan, which establishes land use allocations for Planning Areas, sets Bureau objectives for each resource and class of land use, and lays out guidelines for coordinating multiple uses.

The VRM process concurrently functions parallel with the overall planning process and interconnects at strategic points.

Resource Inventory and Evaluation draws on VRM for Scenic Quality analysis and the identification of enhancement, rehabilitation, or protection opportunities. It also provides essential background information for VRM's determination of visual Sensitivity Levels and Distance Zones. VRM Management Classes and recommendations are reviewed and incorporated into the final Resource Management Plan that sets specific resource activity objectives.

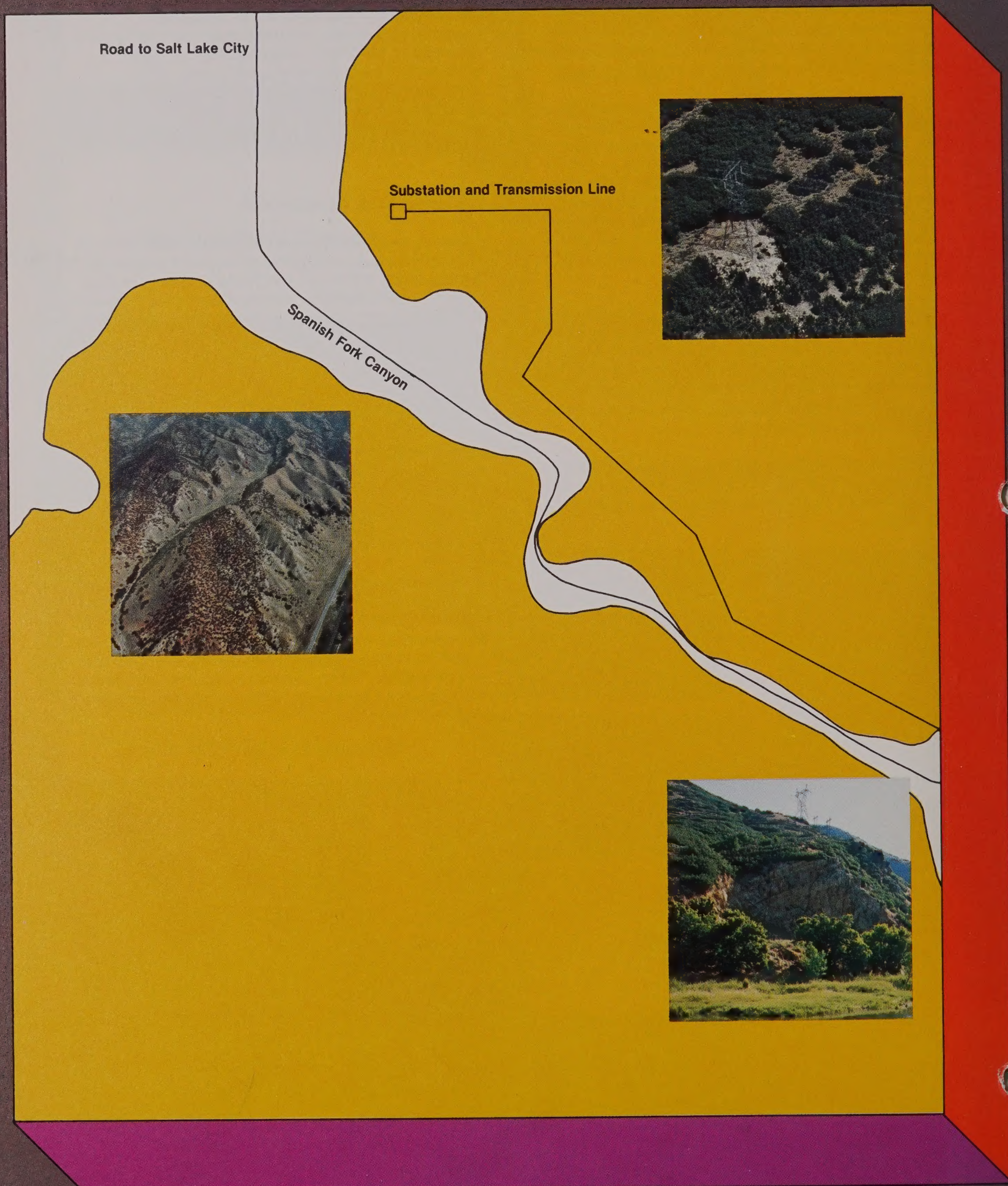
Environmental Assessment

Analysis of potential visual impact is required in all environmental assessments of projects proposed for Bureau lands. Although the depth of analysis may vary, it usually involves several steps directly related to VRM:

- Inclusion in the interdisciplinary team of design professionals such as architects, landscape architects, and land planners who have expertise in visual assessment.
- Description of the existing environment—including Scenic Quality, Sensitivity Levels, Distance Zones, and VRM Management Classes.
- Analysis of impact and proposed action, alternatives, and modifications—including recommendations for mitigating visual impact.
- Summary and conclusions—including VRM recommendations.

The Bureau uses the Contrast Rating System as its primary tool for analyzing the impact of proposed actions. If the Contrast Rating score does not meet the standards for the designated Management Class, specific mitigation measures will be developed and recommended. These recommendations then become the basis for stipulations written into the approved plan.

Application



VRM and Energy Development

Although the general outlines of VRM should now be clear, how VRM works in specific instances is perhaps less clear. Does VRM actually improve visual quality without obstructing the development of essential resources?

The answer is yes, as the following discussion of VRM and energy will demonstrate.

The United States consumes enormous quantities of energy—29 percent of the world's total—even though Americans make up only 5 percent of the world's population. Coal, natural gas, petroleum, hydroelectric stations, and nuclear plants supply most of this energy, although solar, wind, and geothermal energy sources are now put to increasing use.

Nearly all of these sources can be found on the 400 million acres of land administered by the Bureau. The development of these sources, already extensive, promises to increase and accelerate as our nation seeks energy self-sufficiency. As a result, showing how VRM can be applied to energy-related activities without reducing overall productivity offers perhaps the best single demonstration of the system's effectiveness.

Whatever the energy source or the technology used to turn it into power, energy development typically occurs in four stages: exploration, extraction, production, and transportation. The activities performed during each stage can seriously impact environmental quality in general—and visual quality in particular.

Controlling the visual impact of the numerous, massive, and utilitarian facilities required for energy development clearly presents a major challenge to the Bureau and its VRM system. But that challenge is being successfully met.

VRM at Work

The Utah Power and Light Company used VRM concepts in the location and design of a major transmission line. The result was not only mitigation of visual impact but also a demonstration of how proper planning can promote cooperation between a government agency and private industry—and how it can even save money.

Several years ago, the Utah Power and Light Company faced the task of constructing a new transmission line from a power plant at Huntington, Utah, to the Camp Williams substation (located south of Salt Lake City). This line would carry up to 600 Megawatts of electricity at 345,000 volts over many miles of rugged canyon lands and mountains. To support the line, transmission towers six to seven stories high would have to be built all along the transmission route.

Constructing the transmission line posed some real problems of potential visual impact.

A team of government specialists from the Bureau of Land Management and the United States Forest Service reviewed the transmission route proposed by Utah Power and Light. Putting VRM concepts to work, the team established Management Classes for the lands along the route and used the Contrast Rating System to evaluate the power company's proposal.

Certain areas, such as those located near a major recreation site, those easily visible from major roads, and those in highly scenic terrain such as Spanish Fork Canyon, presented cause for special concern—not only to the government agencies but also to people living near the proposed corridor.

After some negotiation of ways to mitigate the visual impact of the transmission line, Utah Power and Light revised its initial proposal. The company hired a landscape architect to develop visual simulations illustrating the mitigation measures it was prepared to undertake. The simulations were convincing, the mitigating measures acceptable, and what otherwise might have been serious problems of visual impact were expeditiously resolved during the project's design stage.

Visual Impacts

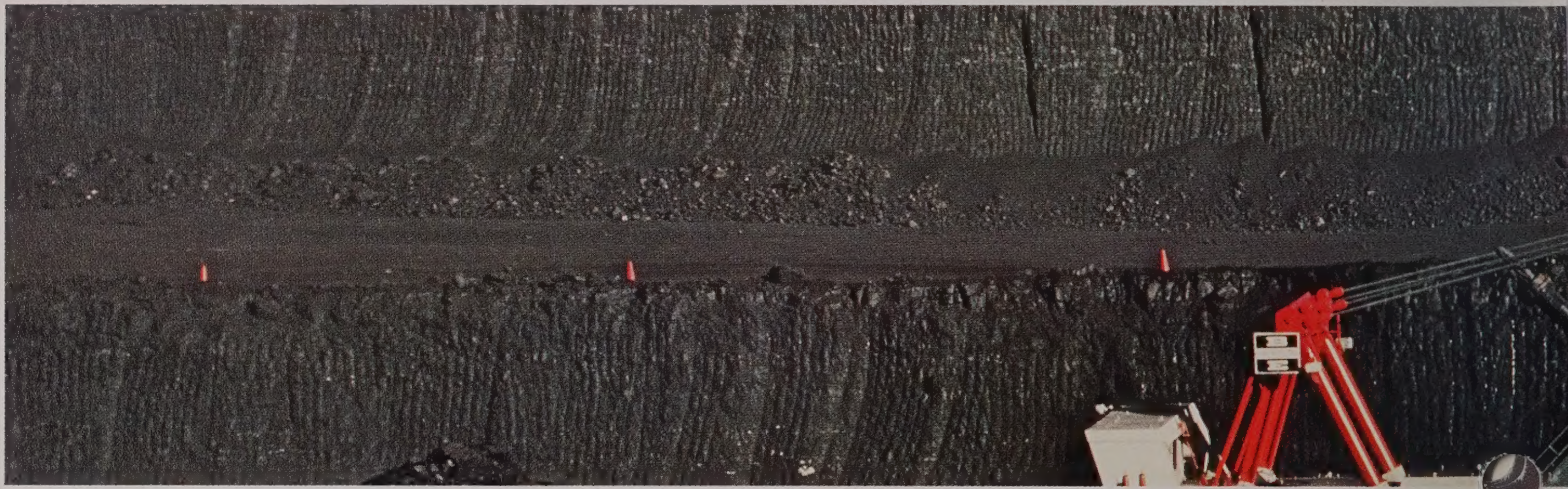
The visual impacts of the Huntington to Camp Williams transmission line, like those of most transmission lines, are caused essentially by the highly visible contrast between the man-made facilities and the natural elements of the surrounding landscape.

In the interests of safety, transmission lines carrying extremely high voltage must be strung well above the ground. The lines run between high towers built at intervals of 750 to 1000 feet. Although the shape of the towers can vary somewhat, they must be more than 100 feet high and made of strong, durable materials like aluminum or steel. The painted or galvanized surface of these metals contrasts strongly with the natural landscape, as do the towers themselves and the long transmission lines.

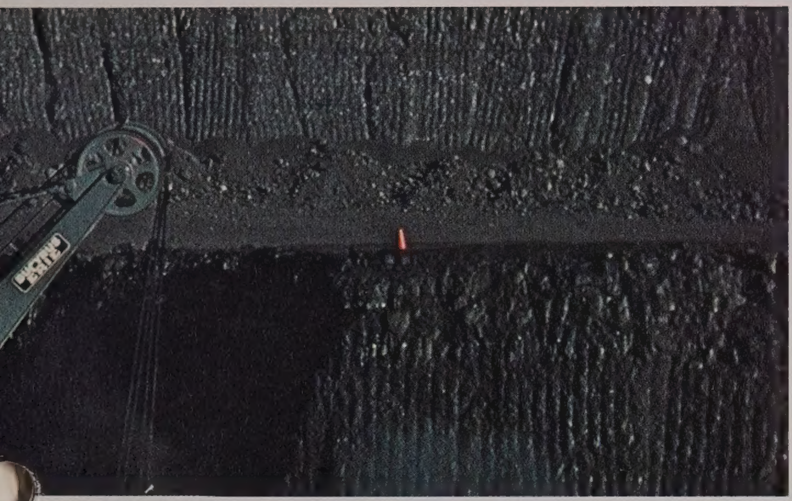
Preparing to construct a transmission line also creates problems of potentially severe visual impact. Access roads must be built for hauling in the structures and equipment needed to level tower sites and to string transmission line. Wide swathes of vegetation must sometimes be cleared along the transmission route. The construction process itself calls for staging areas and storage yards.

Clearly, construction of the Huntington/Camp Williams line involved contrast with the natural landscape in a number of stages. Clearly, too, evaluating varying levels of contrast was an essential first step, so that the government team and the power company could then negotiate acceptable levels of visual impact.

Exploration Specific exploration techniques vary with the energy source and the terrain. In general, however, the techniques include remote sensing, on-site mapping, site clearing, drilling, preliminary excavations, and the construction of retention ponds, access roads, and temporary facilities.



Production Producing energy calls for the construction of electrical generating plants, hydroelectric dams, pumping stations, petroleum tank farms, and many other major facilities. Solar facilities may use acres of solar reflector fields. Geothermal plants produce steam, coal plants produce smoke.



Extracting Techniques will vary. Extracting petroleum, for example, can require extensive well and pump facilities; extracting coal can require large strip-mine operations. Permanent structures are usually built during this phase as well. Because of overburden removal, coal storage in large piles, and construction activity for pipelines and maintenance roads, major modification of landforms often occurs.

Transportation Transporting energy from the often remote locations where it is produced to the consumer requires pipelines (for oil, gas, and coal slurry) or transmission lines. Construction of these facilities as well as the development of extensive maintenance and access roads to such facilities does impact the environment over long linear corridors running for hundreds of miles.

Mitigation Measures

Negotiation and consultation among representatives from Utah Power and Light, the Bureau of Land Management, and the Forest Service produced some specific mitigation measures acceptable to the agencies as well as the general public.

The towers along the Huntington/Camp Williams line were painted in varying colors of matte-finish pigments specially developed to blend with the dark natural landscape. The transmission line conductor was dulled at the factory or was painted on site to decrease its reflectivity and to lessen its visibility.

Where the line passed through areas of special scenic interest seen from roads or recreation sites, the towers were spaced at broad intervals of up to 1600 feet so that fewer towers were needed. Where the line moved across a mountain face readily visible to the public, it was placed high on the mountain, well above a lower existing line. Helicopters delivered towers and construction equipment to the mountain-side so that access roads did not have to be built, and vegetation was cleared only in the immediate vicinity of each tower site. Utah Power and Light used graphic simulations to pre-position towers and lines where they contrasted least with the landscape, screening them with trees, hiding them behind mountain ridges.

Proposed Activity

Results

The cooperative efforts of Utah Power and Light, the Bureau of Land Management, and the United States Forest Service were successful, both economically and aesthetically.

By using graphic simulation techniques to convey its proposals for the reduction of visual impact, Utah Power and Light was able to move through the approval process much more quickly than would otherwise have been possible. The result was considerable savings of time, which, for a company undertaking a large construction project, also means considerable savings in interest costs on money borrowed for construction.

By putting VRM to work, public agencies were able to present their requirements for the mitigation of visual impact in the objective terms of an integrated assessment system.

There have been, and will be, other examples of how VRM can be put to effective use. In the years to come, the continued application of VRM throughout the Bureau of Land Management should bring the Bureau and the public whom it serves ever closer to our national goal of continued productivity and the provision of aesthetically pleasing surroundings for all Americans.

Successful Modification

Bureau of Land Management

As the Nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

U. S. DEPARTMENT OF THE INTERIOR
March 3, 1849

BUREAU OF LAND MANAGEMENT

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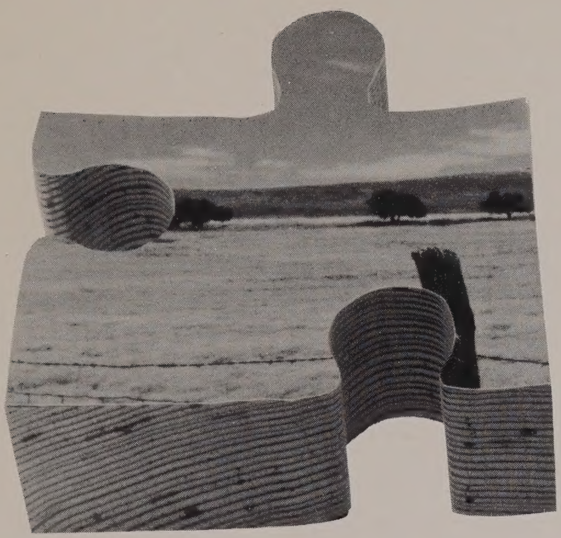
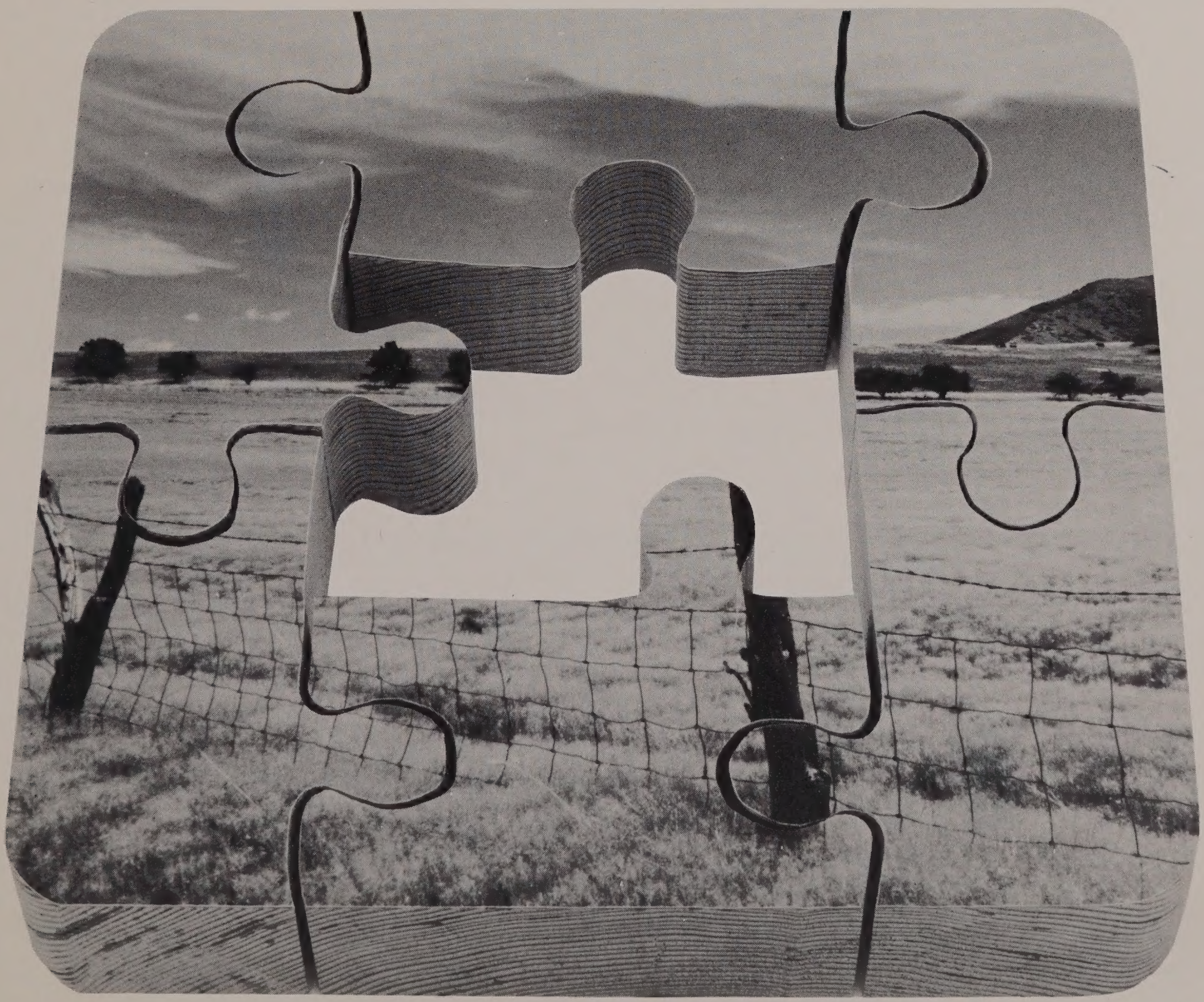
Visual Simulation Techniques





Department of the Interior
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BLM *Division of Recreation and Cultural Resources,* Washington, D.C.

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Simulations 8-Cales Givens; 9-Johnson, Johnson and Roy; 12,13-Recreation Staff, Ashley National Forest, U.S. Forest Service; 11,14,15,16,25,26,27,28-Stephen Sheppard; 4,5,32,33-U.S. Department of Transportation; 31-Jay Roundy; 34-U.S. Forest Service.

Photographs 6,17,23-Larry Green, The Design Studio; 21,22-Roger Ashton.

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Contents

Simulations

One of the most challenging aspects of making land use decisions is assessing the visual impacts of proposed changes accurately enough to judge whether or not those changes are acceptable. Both the land manager and the involved public want to know—and need to know—in advance, what a project will look like when it's done.

As steward of more than 400 million acres of public land, primarily in the Western United States, the Bureau of Land Management has become vitally concerned about the visual quality of the land in its trust. Until recently, this land was used primarily for grazing and occasional mining. The discovery of vast energy and mineral resources beneath BLM lands and the development of large-scale technology to extract these resources have focused increasing attention on Bureau activities. Because of growing public concern for scenic values, and because of the scale and potentially permanent impact of development, land managers and the public need methods they can use to make more informed decisions about resource development.

To meet these needs, a wide array of techniques have been used to simulate potential development. In landscape architecture, a visual simulation is basically a picture—before the fact—of the changes an activity will make to a landscape. It shows what may exist, but does not now, or what does exist, but may not in the future; that is, a simulation may *add* elements or *subtract* them. Because a simulation approximates the effects of proposed activity, alternatives can be studied and adjustments made before development capital and resources are irretrievably committed. The visual impact of an entire project from mineral exploration to land reclamation can be portrayed by simulation before a shovelful of dirt is moved.

Simulations help public groups visualize and respond to development proposals, making public participation in the planning process more effective.

The Bureau's system for Visual Resource Management (VRM) places great emphasis on simulations as a part of the review process to which all projects, both public and private, are subjected. By clearly portraying the impact of a proposed activity, simulations have markedly increased the effectiveness of VRM and other government agency reviews. They have also helped shorten the review process, often dramatically, which has meant substantial cost savings for the project applicant.

This volume provides basic technical information about the rapidly developing field of simulation. Most of the material presented here reflects the state of the art of visual simulation in terms of techniques that are being tested in the practice of landscape architecture.

Some recent new techniques such as holograms, stereo projection, and video tape that are not yet generally applicable to land management have been omitted as have other techniques that lack specific application to the landscape.


Simulated Activity


Simulated Activity
with Revegetation

If you are interested in learning more about the fast-growing field of visual simulation, you may wish to pursue the suggestions presented in the Reference section that concludes this handbook. Listed there are not only publications containing additional information but also names and addresses of key people who are helping to advance the frontiers of our knowledge.

The oldest simulation techniques are, of course, perspective sketches and paintings. Many newer techniques, such as computer graphics, employ other pictorial capabilities. Each technique requires varying degrees of talent and training, and each has an appropriate application. In many of the media skilled artists can achieve an impressive degree of accuracy and realism. This does not imply, however, that professional artists are required in every case to create effective simulations. Often simple and unpretentious graphics can be as effective in communicating as elaborate compositions.

Although many of the photo-related simulations use mechanical processes, some artistic skill and judgment are still required to create hand-drawn elements and also to select and position photographic elements. In almost all instances, minor inaccuracies in scale or perspective will still result in credible simulations. However, greater accuracy and detail will improve realism, which helps audiences focus on major issues rather than on presentation techniques.

Some of the techniques described in the following pages are extremely simple and inexpensive, well suited to quick, general evaluations. Others are more complex and take longer but result in greater accuracy. Some techniques are suited only for personal or small-group use; others are effective for presentations to large audiences. Many of the techniques may be used in combination with each other as well as individually.

The techniques are grouped into three categories: (1) manual techniques that require little equipment, (2) projection techniques that require more equipment, and (3) computer graphics that require rather sophisticated equipment. The intermediate-level techniques which have, perhaps, the widest application receive the greatest attention.

Each technique addresses:
Definition
Procedure
Equipment
Time
Application
Additional Considerations

Technical Supplements, the final section, discusses photographic techniques to improve the effectiveness of simulations, methods for selecting appropriate viewpoints, and scaling techniques to increase accuracy.

Manual Techniques

Many simulation techniques—sketches, scale models, etchings—demand some form of manual skill. Further, most of these manual techniques incorporate some aspect of drawing or painting. Many of the simulations based on manual techniques share common characteristics.

Their visual quality and effectiveness depend largely upon the ability of the illustrator to capture an image on paper. For this reason, manual techniques, although simplest in terms of equipment, may require more specialized ability than many of the more mechanical techniques.

Manual renderings represent the illustrator's personal interpretation of what is important, so elements may be selectively emphasized or diminished by the way in which they are portrayed. The illustrator's subjectivity may be an asset or liability—it may let him focus attention on major issues, but it may also result in a simulation that is biased or inaccurate.

The effectiveness of manual techniques depends on the illustrator's understanding of his subject matter. Since the activities portrayed are often highly technical in nature (power plants, intricate mining processes), good communication between the illustrator and technical specialists is usually essential.

Manual techniques are valuable simulation tools if used judiciously.

Freehand Drawing

Definition Drawings "from scratch" that require the ability to observe or visualize a scene and transmit it to paper.

Procedure Each of the many hand-drawing media has its own particular procedure, too extensive to treat adequately here. Within each medium, numerous styles are possible, from detailed renderings to impressionistic sketches.

Pencil drawings are effective for use in reports. But pen and ink drawings are more effective for most uses and most types of reproduction. They require no half-toning, so reduction/enlargement range is broader. In general, better graphic quality is obtained when drawings are made larger than necessary, then are reduced to final reproduction size.

Time One hour (sketches) to several days (detailed renderings), depending on the accuracy and detail desired, the medium, the size of the drawing, and the illustrator's ability.

Application Realistic, accurate simulations drawn by a trained illustrator should be used whenever possible. The illustrator must have a thorough knowledge of his subject and be experienced in the use of perspective drawing and scaling techniques. Informal sketches by those with less graphic training can also be effective and are often more readily available. Freehand drawings can be used as study sketches for other professionals and as illustrations made for public presentations.

The public responds best to color drawings. For large-audience presentations, drawings should be photographed for slide presentation.

Additional Considerations Uniform media such as pencil, pen and ink, and pastels sometimes produce an overall consistency of tone that may make contrasts (a bright metal building in a "soft" landscape) more difficult to portray realistically. Care should be taken to show contrasts where they exist.

Equipment

- pencil
- colored pencils
- colored markers
- pastel chalks
- charcoal
- pen and ink
- water color/designer colors
- oil paints
- acrylics
- air brush

Rendering from a Projected Slide

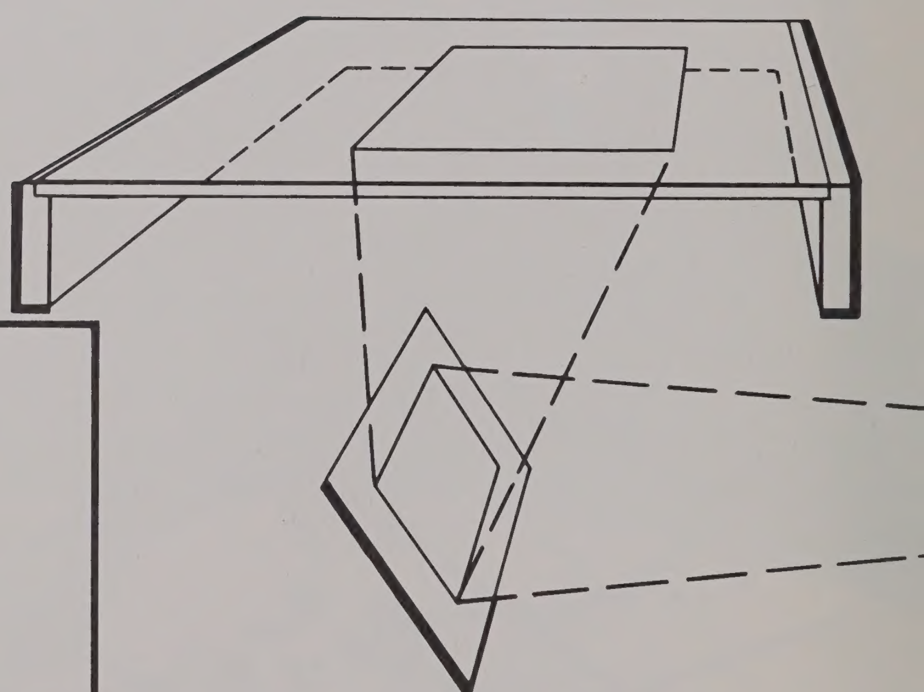
Definition Tracing from a projected slide. The simplest way to ensure the objectivity and accuracy of hand-drawn sketches, this technique is an effective short-cut to greater realism that allows a relatively untrained person to turn out a reasonably well-executed product.

Procedure A slide of the landscape is projected on a sheet of paper fixed to a wall. (The projector can be moved forward or backward to adjust the size of the image.) The landscape is traced first and the major features outlined, with shadows, trees, etc., filled in with shading or cross-hatching later if desired. A mirror-reflected projection onto a light table (or a semi-transparent glass or plastic surface) will provide an alternative to a wall-mounted paper and will supply a comfortable, untextured surface on which to trace.

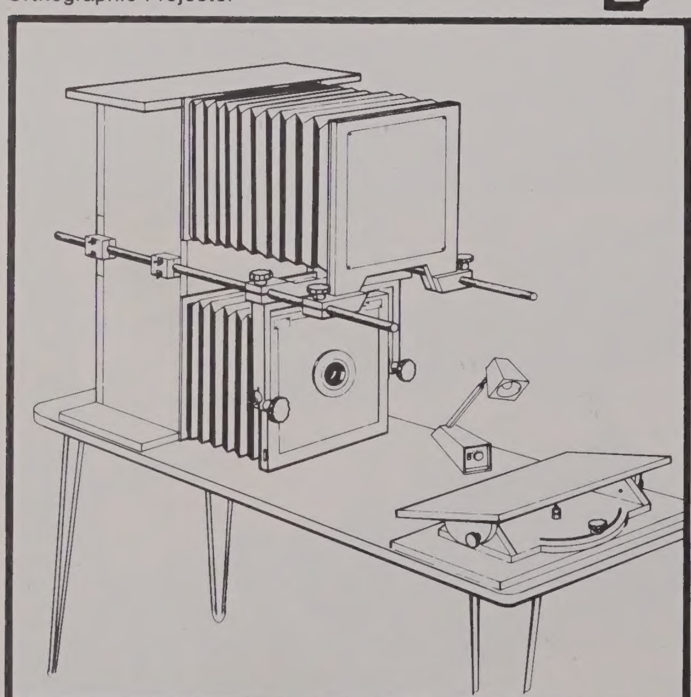
An image of the proposed activity, if available, is then projected onto the tracing of the background setting and adjusted to the correct scale, again by moving the projector backward or forward. If a slide of the proposed activity is not available, a picture or diagram can be projected by means of an opaque or overhead projector.

The slide tracing of the superimposed image will often be somewhat coarse in character. Unless time is severely constrained, this rough version should then be retouched or redrawn (by means of a tracing paper overlay) for greater consistency.

Drawings made with pencil or pen (soft-tip) are easier and quicker to make than those using other media. Color may be added to the drawing as a second or third step. Better graphic quality is obtained when drawings are made larger than final reproduction size and then reduced.



Orthographic Projector



Time Up to several hours for an average simulation, more if exceptional detail is desired.

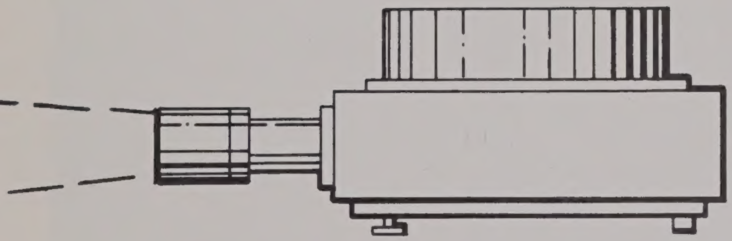
Application Drawings from slides are extremely useful for quick visual studies as well as for final presentations, either to an audience or in a report. As with freehand drawings, the consistency of the medium may soften contrasts between materials (natural vs. man-made forms) and thus somewhat reduce realism.

As was suggested earlier, drawings should be photographed for slide presentations. Color slides are more successful with audiences than black and white slides.

The final product combines much of the accuracy of a photographic display with the informality and warmth of hand renderings, yet still allows some artistic license in emphasizing certain features.

Equipment

- slides of setting and proposed activity
- slide projector
- light table (optional)
- mirror (optional)
- drawing materials



Additional Considerations Drawings from slides can be completed indoors so the illustrator's presence is not required on location.

Where conditions dictate, the subject may be drawn on paper that bears a projected photographic image of the landscape and the resultant combination rephotographed. This variation produces a before/after slide display and makes drawing the landscape unnecessary. Results are particularly effective when activities such as roads or transmission lines are simulated.

Another method to increase the accuracy of a hand-drawn rendering involves the use of an orthographic projector. With this equipment an oblique image can be projected from the flat surface of a map onto a viewing screen, where the artist sketches the proposed activity and the existing landscape. This system is best used when lands are fairly uniform in slope and without many ground irregularities.

Original Photograph

Rendering

Diazo Print

Definition The illustrator's conception of a proposed activity applied to a diazo reproduction (mylar acetate or paper print) of a landscape setting.

Procedure From a photograph of the site, a reverse mylar or acetate sepia positive (half-tone), is made (8x10 minimum, larger sizes are easier to simulate). The proposed activity is drawn on the front side of this reproducible enlargement. The original image beneath the proposed activity is then chemically eradicated on the reverse side. Dot screens or other aids may be used to give texture or shading to the new image. Any number of copies may then be made in a diazo print machine. A duplicate copy of the original is desirable to show the site without the proposed use.

For presentation, color may be added to a print and photographed for slide presentation, or an uncolored print may be reduced for use in a publication. For reduction purposes, care should be taken not to use a dot screen that is too fine.

Time Several hours. Relatively quick because only the proposed activity need be illustrated.

Original Photograph

Application This technique is quick, simple, and suitable for producing many large copies inexpensively. The size of the images may limit the size of an audience. But the simulation can easily be used in reports or reproduced in slides.

This technique is particularly useful for conceptual simulations, since the contrast between the applied image and the photographic background is usually quite noticeable and the realism less than with some other techniques.

Additional Considerations An alternative method is direct retouching of a diazo paper print (blackline), usually with acrylic paints in greys to match the photographic base. In this way realism can be substantially improved, but the final product is black and white (not color) and not easily reproducible.

Another alternative is to expose print paper directly from a slide with no intervening mylar enlargement. Since a lengthy exposure (10 to 30 minutes) is usually required, a slow-print paper can be exposed in a low-ambient-light room; total darkness is not required.

Equipment

- positive black-and-white photo of setting
- reproducible enlargement (from photo)
- diazo print paper, photo acetate or mylar
- diazo print machine
- pen and ink
- dot screens
- mylar or sepia eradicator

Diazo Paper Print
with Simulation Added

Rendering on a Photograph

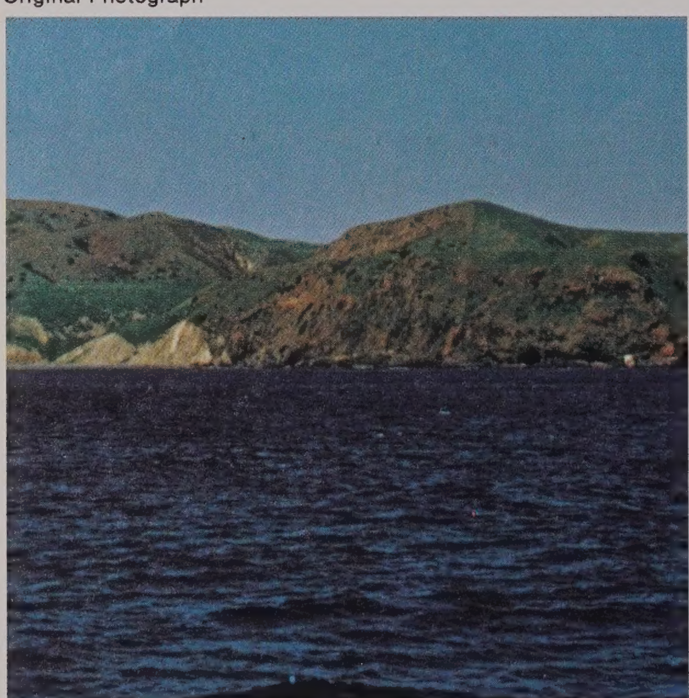
Definition A subject is "painted in" by applying paint or dyes to the surface of a photograph (color or black and white). This technique is also used in *reverse*: "painting out" an existing activity to show a landscape restored to its natural condition.

Procedure Painting over photographs is typically done with retouch dyes, watercolors, or acrylic paints, using fine-tipped brushes or airbrush. The illustrator will first refer to detailed photographs or drawings of the proposed activity (or, for reverse simulations, make a close examination of the adjacent natural terrain). Next, a simple image of the proper size and in the proper perspective is constructed on a transparent overlay, positioned on the photo, marked with reference points, and, finally, painted.

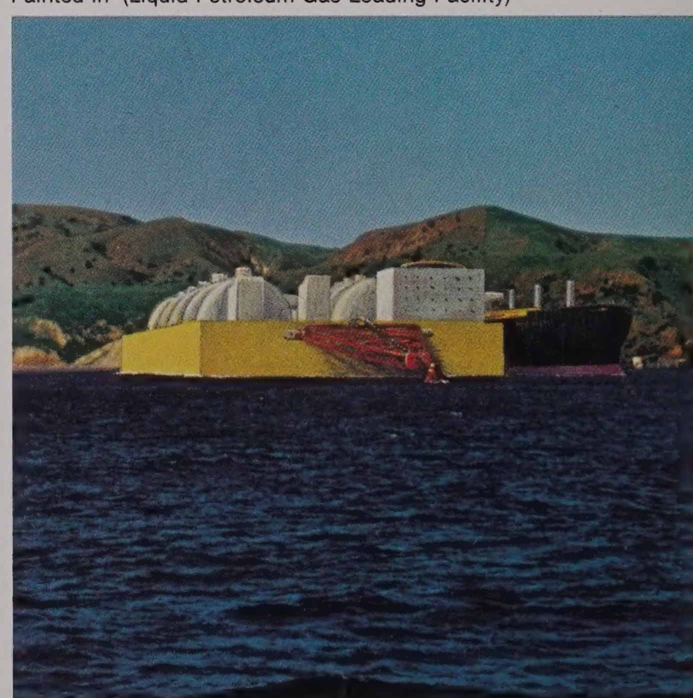
The illustrator must be able to match the colors of the photograph accurately, paint at minute scale, and carefully duplicate the effects of distance and light on the new forms in the landscape. Realism may be enhanced by adding line and subtleties using erasure rubbing, pin scratches, etc. For large uniform surfaces (lakes, roads), colored adhesive screens may be substituted for paint.

Working on a photograph somewhat larger than final size (8x10 or larger) will increase the detail and accuracy of the simulation. Final reduction to format size usually removes slight imperfections and improves overall quality. Rephotographing the finished simulation will further add to realism by eliminating the contrast between the matte finish of the paint and the glossy surface of the photograph.

Original Photograph



Painted in (Liquid Petroleum Gas Loading Facility)



Application This often-used technique is suitable for almost any subject matter. The media available allow representation of almost any material (metal, vegetation, water) with a high degree of realism. With this technique, the size of the base photograph will affect the final simulation. For example, graphically simpler projects such as a gravel pit or storage tank will be easier to illustrate on a small photograph than complex power generating stations. With the proper medium and base photograph, a high degree of realism is possible, since the perspective, scale, color, and shadow can all be finely matched to the background photograph.

Photo renderings are usually best presented in rephotographed slide form, since the originals are often too small for any but individual or small-group viewing.

Additional Considerations The ability of the illustrator is critical to the degree of realism achieved with this method of simulation. Because of the specialized training required, using an experienced illustrator will generally result in cost savings.

Audiences generally enjoy photo renderings, particularly those that are highly realistic. They can also be fascinated by the illustrator's skill, so care should be taken to focus attention on subject matter rather than on presentation technique.

Equipment

- fine-tipped brushes (or airbrush)
- acrylic paints, retouch dyes, opaque watercolors
- photographs (preferably matte-finish) of setting and proposed activity
- magnifying glass
- pins, erasers

Original Photograph

Reverse

Etching on a Slide

Definition Direct alteration of a slide. Because etching is technically difficult, it should be used only when other options are precluded and when very simple modifications are to be shown.

Procedure The photographic emulsion in the area to be simulated is chemically removed or gently scratched off and the proposed modification painted in with a translucent (non-opaque) color medium.

Time Up to 2 to 3 hours.

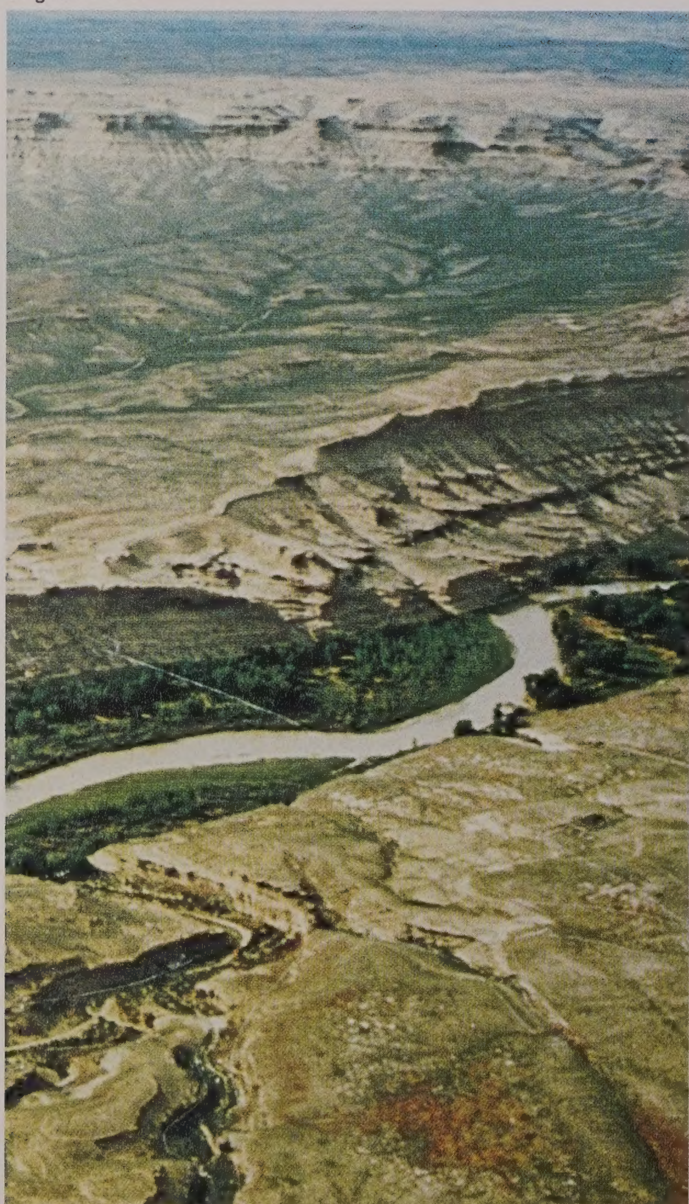
Application This technique is somewhat less realistic than others, because the small scale limits the incorporation of detail and because matching translucent media and slide colors is difficult. Slide projection also magnifies all of the imperfections. Etched slides may, however, be valuable for conceptual simulations at a study level when a great degree of realism is neither necessary nor possible.

Additional Considerations Where proposed cultural modifications are linear, with crisp edges (power lines, towers, storage tanks, walls), etching on a slide with a fine needle gives useful results. A clear image will appear white on a projection of the slide, which produces a quick, though somewhat crude, simulation. Color transparencies of various sizes can also be used.

Equipment

- slides: color (Ektachrome if chemicals are used) or black-and-white positive
- emulsion remover (available from Kodak)
- needles and fine-bladed knife
- magnifying glass
- fine brushes
- light table
- translucent media (paints, markers, etc.)

Original Slide



Etching

Multi-Image Printing

Definition Combining color transparencies of several separate images into a single composite print—by printing sandwiched transparencies, or by "combination printing."

Procedure "Combination printing," or double printing, involves making multiple exposures from two or more transparencies onto a single sheet of paper.

In the darkroom, first the background and then the image is exposed onto the same photographic paper. The image area and the background on each transparency (or negative) must be opaqued or "dodged" out. Dodging consists of holding an opaque sheet (which may be trimmed to a specific shape) below the enlarger to block the light from selected portions of the photographic paper during exposure. Slightly shaking the dodge sheet during each exposure will "feather" the boundaries and make transitions less noticeable.

Time Usually less than 1 hour, if equipment is readily available.

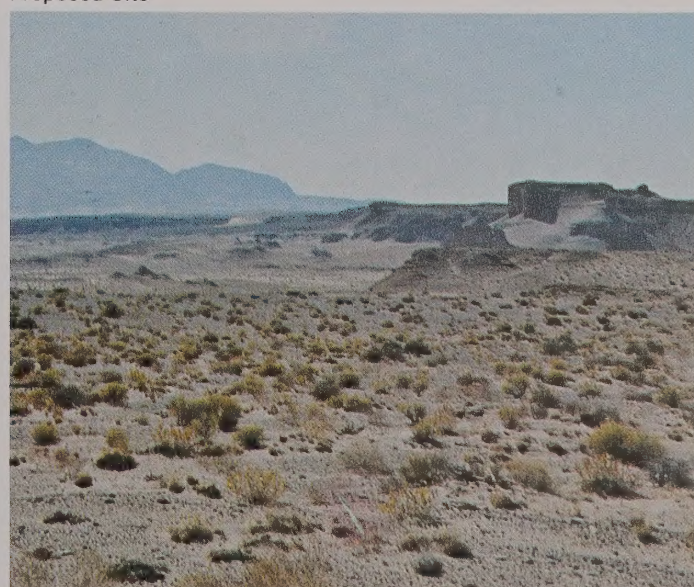
Application Realism can be outstanding. Using a color print for presentation, however, limits the size of the audience. Preparing a slide from the print increases the potential for viewing by a larger audience.

Equipment

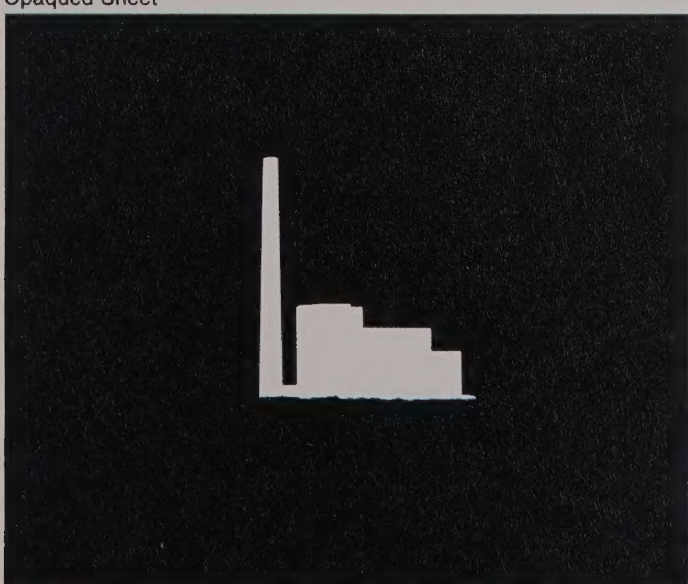
- transparencies
- darkroom color printing equipment

Proposed Activity

Proposed Site



Opaqued Sheet



Final Multi-Image Print

Photomontage

Definition Parts of one photograph pasted down upon another photograph. If the proposed modification is a structure, and a reasonably accurate example can be placed in a setting similar to the proposed site, this is one of the simplest and most effective simulation methods available.

Procedure When prints are overlapped, the cut edge of the paper is thick enough to be seen, which may not be acceptable for public presentations. Two methods can be used to overcome this difficulty.

One technique is to overlap two photographs, cut both prints at once, then butt-join the remainders as one would a jigsaw puzzle. Since the prints stretch and shrink as the relative humidity changes, butt-joined montages often develop visible cracks at the joint lines, so they should be photographed immediately.

A preferable method is to overlay one photograph on another and feather the edges to reduce their visibility. Feathering requires some practice, but once mastered can be done quickly and effectively. It is necessary to cut lightly through the emulsion just into the paper base, (leaving enough uncut base so that it will tear and provide a beveled edge). Once the cut has been made, turn the print emulsion down, fold the unwanted portion of the print up at the cut, and tear off the excess material. Make this tear at approximately a 45° angle to the line of cut. The feathered edge should be smoothed with sandpaper to an almost undetectable thickness along the cut edge. Gum arabic is the preferred adhesive because it is water soluble, sets in about fifteen minutes, and dries in an hour or two. This gives some leeway in which to slide the pieces around to get the best fit.

Original Photograph

Time Usually less than 1 hour. Actual composition time may be very short, but finding appropriate photographs can be time consuming.

Application Photomontage is best suited to simulating hard, constructed elements in a landscape. It is much less useful for portraying roads, landforms, vegetation and other "soft" elements, or very fine and intricate subjects such as power lines and objects seen through branches.

Photomontage is very effective for photographic reproduction in publications or for display to individuals or small groups. For large groups, rephotographed montages presented in slide form are more effective.

Additional Considerations Rephotographing a montage reduces the visibility of joints. The realism achieved with this technique can be striking, especially if attention is given to certain variables.

Retain some grass and shrubs in the cut-out image to soften hard edges and to make the structure fit more naturally into the landscape. Avoid settings that have trees, wires, or fences in the foreground which will overlap the buildings to be superimposed, since fine-textured elements are difficult to cut out of photographs.

Equipment

- required photos (4x5 minimum, preferably larger)
- craft knife
- gum arabic

Photomontage

Scale Model

Definition Three-dimensional simulation of an activity and its setting. Models provide many viewpoints for evaluation, and they may also be successfully incorporated into other simulation techniques.

Procedure Model-making may be either additive or subtractive, that is, either built up or carved out of various materials. Built-up landscape models are the most common because the materials and equipment are usually available and the procedure is relatively simple. More realistic and intricate site models can be carved out of solid blocks of styrofoam or other lightweight material by a special router that removes material as it shapes contour lines. Several private firms build these rather specialized types of models. When landforms are complex or a high degree of realism is desired, sculpted models purchased from an outside supplier may be no more expensive than built-up models constructed in-house.

Built-up models may be constructed out of laminar materials such as paper, illustration board, cardboard, wood veneer, or even plywood. Techniques vary slightly with each material, but the general procedure is to cut out layers that correspond to contour intervals and mount them one on top of another to recreate the desired terrain.

Realism may be increased by beveling or filling in the contour steps, spraying with natural colors, and simulating vegetation.

Spray paints in several shades of green and brown can be overlapped to achieve a realistic ground appearance. Larger plant materials can be approximated in miniature with dried weeds or

Berkeley Environmental Simulation Laboratory,
University of California

materials such as sponge, steel wool, or sandpaper. Adding details such as vegetation and color will greatly enhance the illusion of reality. Scale references such as miniature people, cars, or telephone poles will allow an observer to recognize relative sizes of unfamiliar objects. Models of structures should carefully portray building form, size, and color, since these characteristics and their relationship to location are major issues for visual impact analysis.

Time At least several days. Even simple models can be extremely time consuming.

Application The scale model has two primary applications— a rough model for study purposes, or a refined model for public display. One limitation: realism in a model is totally dependent on the ability of the craftsperson, particularly his/her ability to duplicate natural elements, and models seldom achieve the realistic detail possible through photographic techniques. A second limitation: only a few people can view a model at one time. However, a model may be the only way to convey certain information, such as the total context of a project or the sequence of views along a road.

Models may also be used effectively in other ways. A photograph or projected slide of a rough study model may be traced as a guide to sketch a landscape setting. Miniature periscopic camera attachments can be used to take "eye-level" photos along a view sequence or in tight spaces, producing results that very closely resemble what the observer of a full-scale model would see. Where no examples of a proposed structure exist, a model could be photographed and the photograph used as one element of a photomontage.

Scale Model at Eye Level

Additional Considerations Size should be appropriate. An oversized model may be too expensive and overly detailed for effective evaluation of major concepts. A model at too small a scale may be too general for effective evaluation.

It is possible, though very expensive, to construct extremely realistic models and present them through sophisticated viewing mechanisms. The Berkeley Environmental Simulation Laboratory, for example, can hold a model 1200 square feet in size. It has a computer-controlled periscopic TV probe which moves on two axes and lets a viewer visually "travel" on the TV monitor along various routes through the model.

Equipment (for built-up models)

- topographical map and facility plans
- model materials (plywood, cardboard, etc.)
- cutting equipment (matte knife, jig saw, etc.)
- plant materials (natural and artificial)
- spray paint
- glue
- mounting base
- miscellaneous miniatures (cars, people, etc.)

Examples of Detailed Scale Model

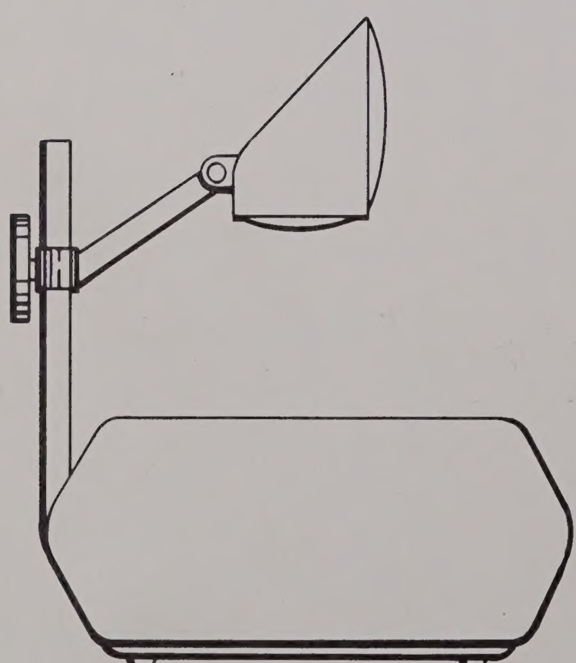
Projection Techniques

Manual skills play a relatively minor part in this second category of techniques, which uses transparent overlays superimposed on slides which are projected in different combinations onto a screen. The results can either be used directly for audience presentations or rephotographed for other presentations, publication or permanent recording.

Images can be introduced into slide projections in several ways. An opaque image (line or mass) can be made on the transparency to block out light and produce a black image in the projected display. This method is particularly suited to simulating such elements as power lines, poles, fences, trees and other objects which often appear in silhouette. Its use for buildings is limited, since multiple planes, depth, color, and surface texture cannot be portrayed.

A second method involves placing an opaque image (silhouette) of the proposed activity over the background transparency (setting). Onto the *negative* area created by the opaqued silhouette, a second source projects the *positive* (color) image of the same activity with its background carefully opaqued. The negative image and positive image line up, producing a projection montage.

A third method introduces variations in shading and color. One projector displays the setting; in a second projector, a negative of the image (in background black) casts a white silhouette on the screen, "washing out" the background beneath the image. Color, line, tones, or textures may then be applied over the negative image to change the paint color of transmission poles, for example, or create a roadway surface.



Proposed Site

Single Overhead

Definition Use of a single overhead projection unit to project either a retouched viewgraph transparency or a transparency with simulation overlays.

Procedure A color slide of the desired landscape is enlarged to a 5x7 or 8x10 viewgraph transparency. The proposed activity is rendered either directly onto the transparency or onto a clear plastic overlay. To keep the background from reading through, the image must be opaqued or its colors must be extremely dense.

The simulation should be rendered on a light table for maximum visibility of the base photograph and for accurate fitting of activity to vegetative features and geomorphology. Overlays may be hinge-taped to the transparency to assure registration and easy set-up. Adding shadow contrast to the base photograph will heighten the realism of the final simulation.

Time Approximately one-half hour. Renderings must be fairly simple to be easily illustrated.

Application An overhead projector and screen work well for use with large audiences. However, the results depend totally on success of the opaque image.

Additional Considerations When a rough, conceptual image is all that is required, an alternative method is simply to outline the image, either directly on the base or on an overlay, and allow any background to read through. Although this produces minimal realism, it allows the audience to envision simple structures, particularly large ones, quite well.

Equipment

- overhead projector
- viewgraph transparency of slide
- mylar or acetate sheets
- rendering media (drafting pens, opaque ink, self-adhesive color film, etc.)

Opaqued Image

Outlined Image

Slide/Overhead

Definition A color-slide projection with one or more overhead projectors superimposing an image onto a background setting.

Procedure A slide of the selected site is projected onto the screen. Heat-resistant glass, spray-painted opaque black, is placed on an overhead projector. The black paint is then scribed to outline a silo or other proposed activity, which shows up as a white image on the projected slide. An alternative method is the "frisket" technique, where all but the required image is masked out. To add realism, such as bare earth during construction or revegetated young growth, a clear plastic sheet over the scribe glass may be colored with a felt-tip marker or a color sheet of clear plastic may be used.

A second viewgraph projector may be used to add copy or another image.

To correct a mis-scribed plate, dark fingernail polish, black paint or opaque model-airplane glue can be applied with a small brush.

If alternative images are to be considered, several sheets of glass and clear or colored plastic will be needed. To ensure identical scales and proper alignment of all the projected images, two *tiny* needle pricks should be made in the upper and lower corners of the slide and corresponding marks made on the glass and plastic overlays.

Time Up to several hours.

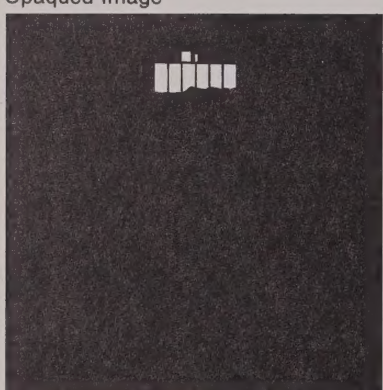
Application This technique can be used for direct presentation to large or small audiences and will hold their attention because simulation is actually created before their eyes. Realism is relatively good when color values are accurate. Although the equipment required is relatively simple, the project simulated should be one with several alternatives to justify setting it up.

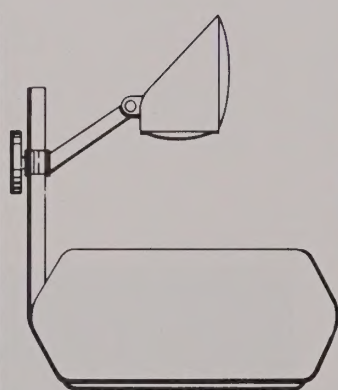
Additional Considerations Similar results can be achieved by substituting an overhead projector and large transparency for the slide projector.

Equipment

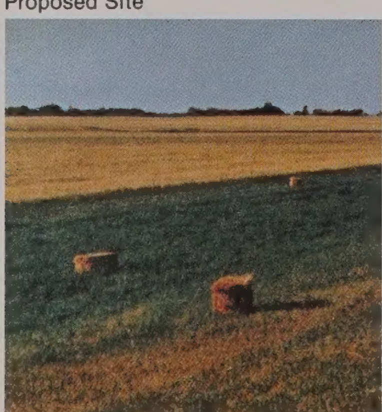
- slide projector
- overhead projectors (2)
- slide transparency
- heat-resistant glass plates
- opaque paint
- scribe
- acetate sheets
- transparent color media

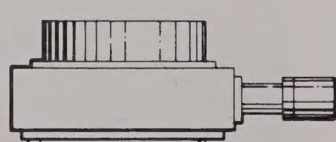
Opaqued Image





Proposed Site





Projected Image

Overslide (Overhead)

Definition Color slides projected through overhead projectors, superimposed into a single image on the screen.

Procedure A bottom-access overhead projector and an overslide projection cabinet can project multiple slides of the site and the activity onto a screen. Proposed activities are simulated by drawing or laying prepared opaqued overlays on the overhead-projector light stage.

Several overslide units may be used together, all aligned precisely on the same frame, each one projecting a portion of the simulation (image, background, etc.), with the unnecessary portions of each image blacked out on the overhead projector glass.

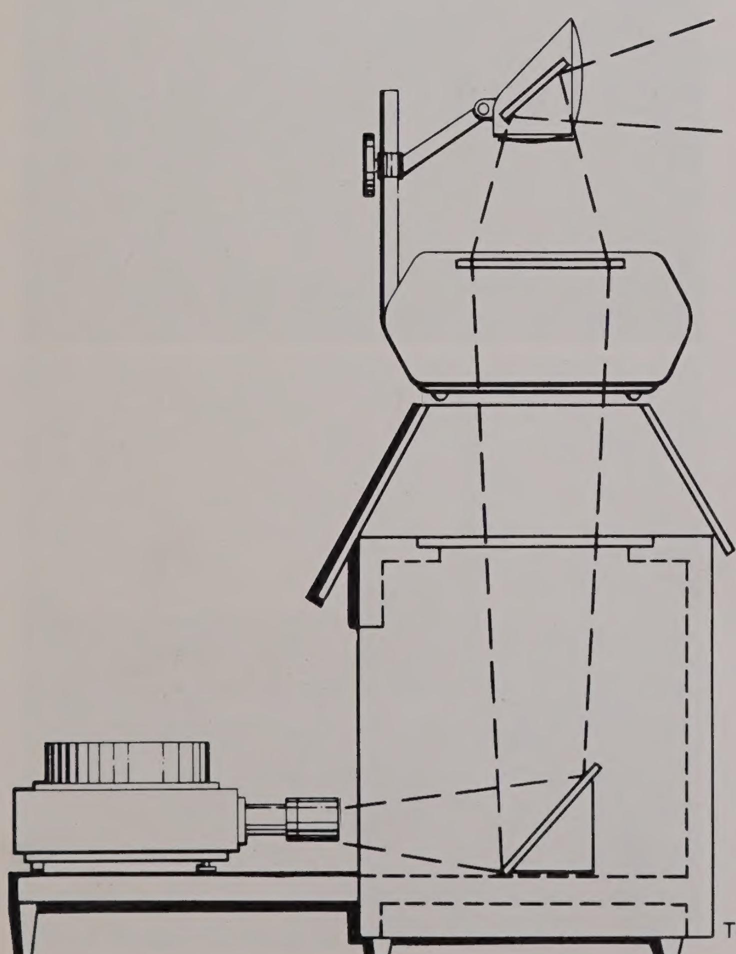
Time One to several hours.

Application This projection method is only marginally useful for reproduction. However, drawing in a proposed development while an audience watches can be particularly effective.

Additional Considerations The amount of realism possible is only moderate because the system does not have the light-intensity adjustment needed to get truly acceptable color value and balance.

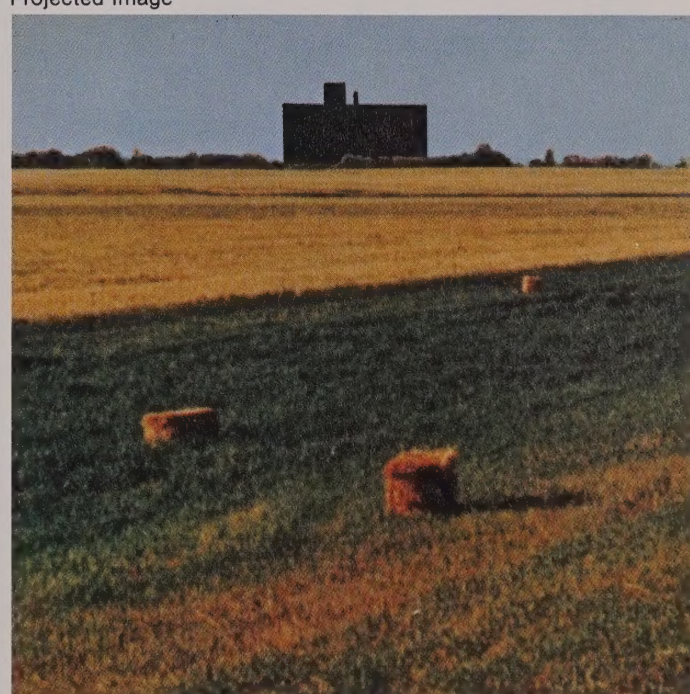
Equipment

- overhead projector with bottom projection capability
- overslide projection cabinet (often custom-made)
- slide projector
- acetate or mylar overlay for simulation
- line and transparent color media
- opaquing paint



Thermofax 43 Cabinet

Projected Image



Slide-Projected Montage

Definition The images of two or more slides projected simultaneously on a viewing screen.

Procedure Typically, the precise area for the proposed image is opaqued on a slide of the background setting, and the background is opaqued on a slide of the proposed image. The opaquing should be done on the non-emulsion side so it can be removed (for corrections) without damaging the image.

Since opaquing must be done directly on 35-mm slides, achieving a precise match of the image and the opaqued area is difficult. A light table will facilitate aligning overlayed slides (which should be done from the slide mounts). The projected image of any slide may be adjusted to match that of any other by adjusting the distance or alignment of the projectors.

Time Up to several hours. Since no hand drawing is required, time is limited to that needed for careful silhouetting on the slide.

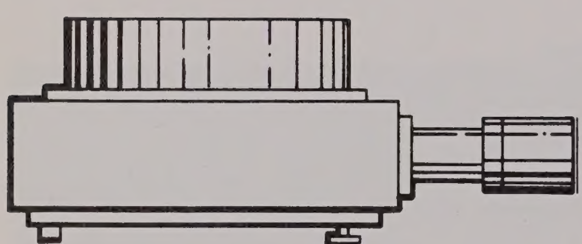
Application If variations of lighting and color tint can be kept to a minimum, this technique tends to produce a simple and fairly realistic simulation. As with all simulations used with slide projectors, this is suitable for audiences of any size. If several alternatives are to be shown, however, there may be some awkwardness in re-aligning projectors each time.

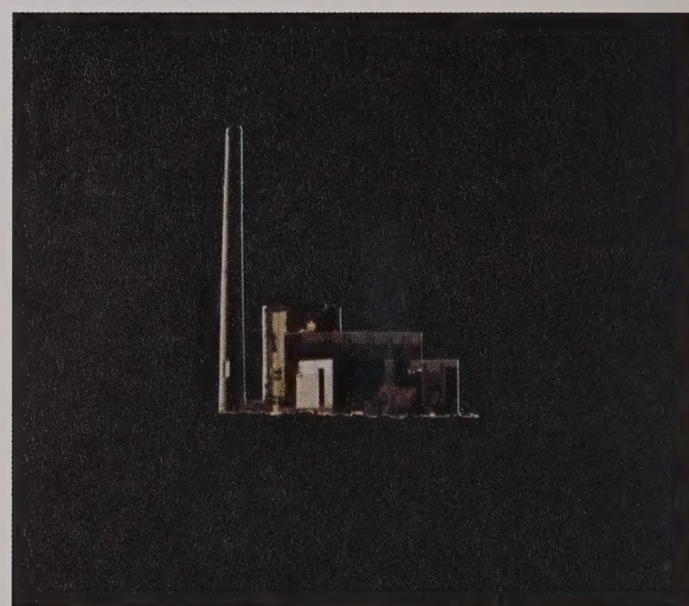
Additional Considerations Since nothing is actually rendered, no loss of detail or realism will occur for lack of artistic skill.

Equipment

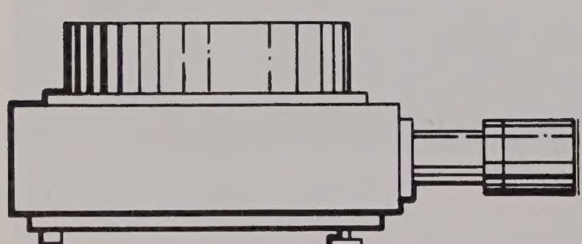
- slide projectors (2 or more)
- slides of object and setting
- opaquing medium
- fine brush
- fine-point drafting pen
- light table
- slide mount replacements

Proposed Activity





Proposed Site



Multi-Screen

Definition Surrounding an audience with projection screens illuminated by several projectors that collectively show a broad field of view. (Views of up to 360° are possible.)

Procedure Using a tripod, the photographer shoots a frame and then rotates the camera until the edge of the second frame matches or nearly matches the edge of the first frame. This process can continue to complete any size of arc or a complete circle. If a small gap is left between frames, nine shots will produce a complete circle when a 35-mm camera and 50-mm lens are used. It is difficult to match every frame perfectly. However, the greater the overlap from frame to frame, the better the match. Even a near-match, though, will yield realistic results.

Simulations are created for each projection area by any of the techniques outlined in this section.

In presentation, a screen or screens are set up to form an arc or circle. Projection onto the screens can be from the rear, from the center, or from the perimeter of a circle.

Time Depends upon technique used. Potentially longer than other presentation methods if multiple simulations are required for any given scene.

Application The audience size will be limited by the enclosure size created by the screens. The technique is very well suited, however, to repetitive showings or to an exhibit.

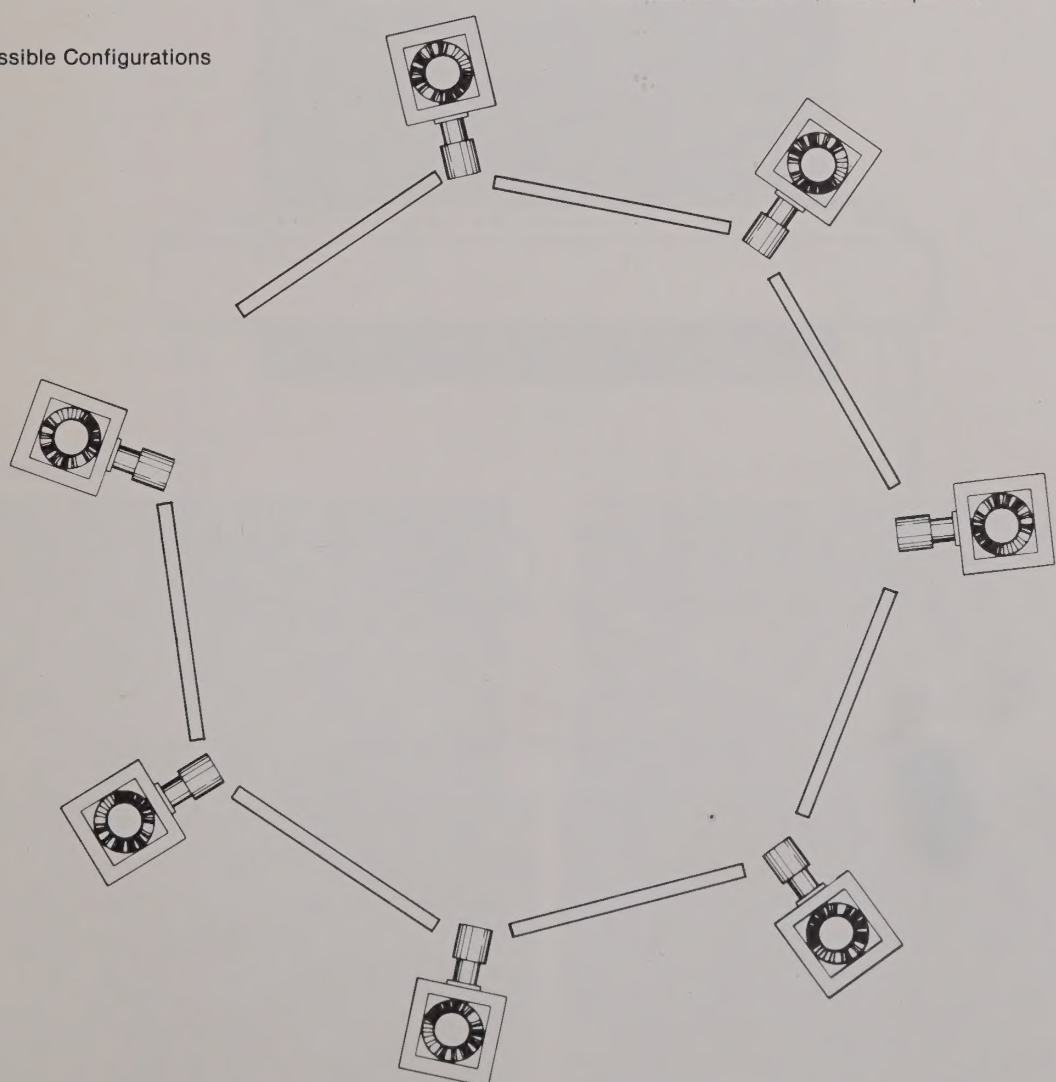
A criticism occasionally voiced about many simulation techniques is that they fail to show the broad context of an activity. This method, more than any other, answers that criticism; it gives the audience the impression of being *in* the setting, getting them involved in the total site context. Also, the technique is particularly useful for simulating projects that would cover potentially large land areas or for which many views from a particular point are significant.

Additional Considerations This can be an effective technique if each of the individually simulated frames is well done. However, problems in matching the frames can detract from the presentation.

Equipment

- camera, tripod, slide film, etc.
- projectors and screens (up to 9)
- simulation materials for technique used

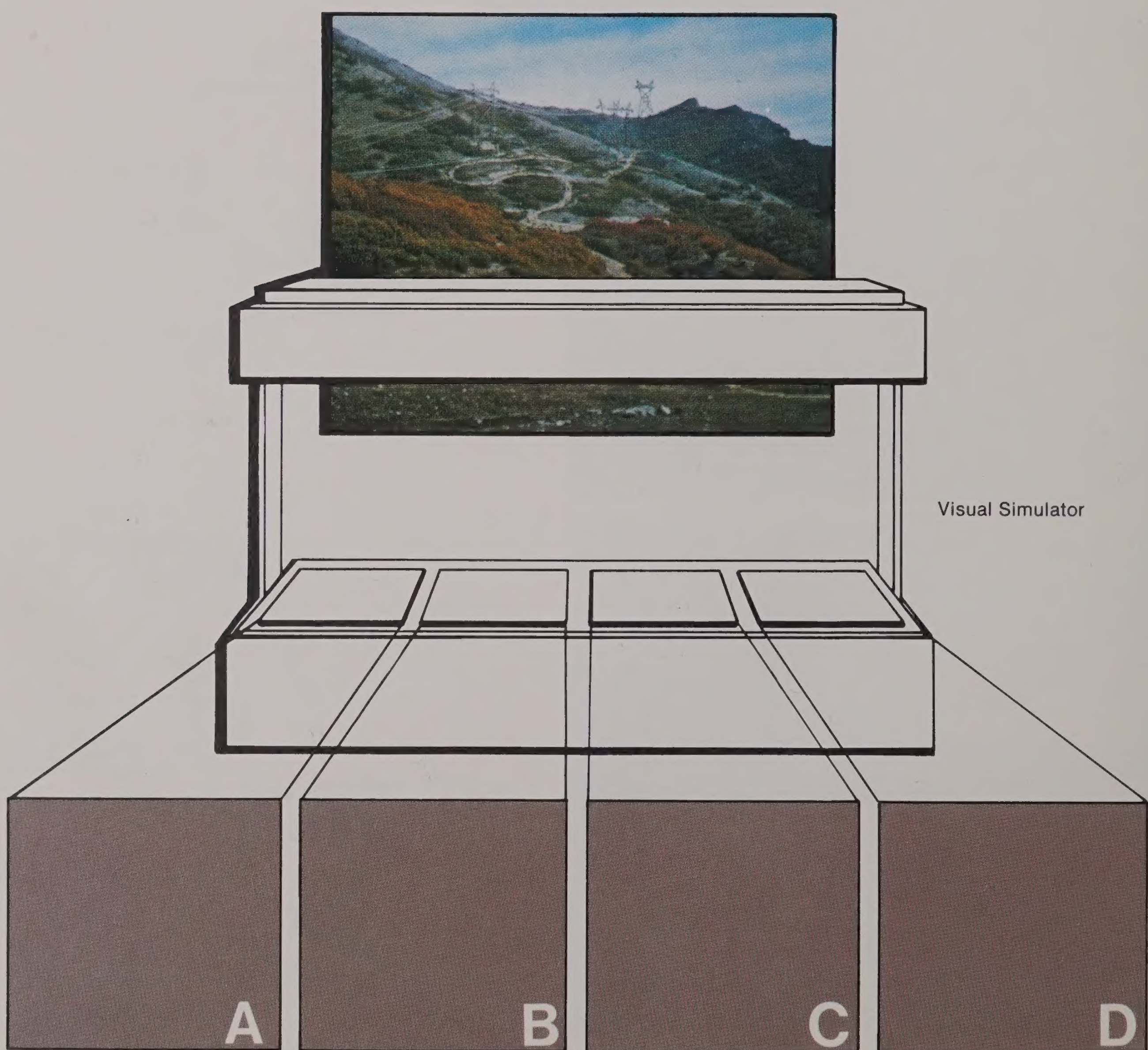
One of Several Possible Configurations



Multi-Overhead

Definition A sophisticated simulator that uses four overhead projectors to superimpose multiple transparencies and overlays into a single image. This simulation technique provides one of the best methods to illustrate realistic color of proposed activities. The system is versatile, allowing the presentation, labelling, and coordination of a number of alternatives. Light intensity is controllable.

Procedure All four projectors are first carefully aligned on the same screen. **A.** A color transparency of the existing landscape is positioned on the first projector's light stage. On top of this transparency is placed a positive image overlay with all of the proposed activities (i.e., transmission lines, towers and roads) appearing as a black image. This results in a projected landscape scene with the proposed activities appearing as a solid opaque image on the screen. The overlay, when combined with the landscape transparency, will block out all color in the exact area of the proposed activity. **B.** On the next projector's light stage, a negative of the same proposed activities is placed. This sheet, which blocks out all light from the projector with the exception of the proposed activities (i.e., transmission lines, towers and roads), allows for intensive light to be focused directly onto the activity area. At this point the proposed activities will appear as white images on the screen. **C.** The third projector allows a color to be added to the proposed activity by using transparent color sheets or combinations thereof. The appropriate color transparency is laid against a negative image of the proposed activity or activities that have the same color requirements (i.e., towers and transmission lines will both be grey). This combination is then placed upon the third light stage.



Visual Simulator

Step C allows the color to be projected directly onto the activity area only. **D.** The fourth projector provides the option of adding a different color to another activity within the same scene (i.e., roads). This is especially useful when different color requirements are necessary for various proposed activities within the landscape. This projector can also be used for the addition of titles and other graphic illustrations.

Time Up to a day, depending upon complexity of the simulation and experience of the operator.

Application The simulator can be used to make a presentation to an audience of any size. It allows the viewers to see the simulation appear piece by piece and offers exceptional realism (especially for showing power lines). It is, therefore, one of the most effective techniques to present to an audience.

Rephotographing is not entirely successful because of a slight, darkish halo appearing around the border in photographs, but can still be effective.

The simulator equipment is less mobile than other systems; it is large, heavy, and somewhat sensitive to the stresses of being transported.

Additional Considerations This is one of the few techniques that can be used to insert "non-structural" images (excavations, roads, etc.) into a landscape by using transparencies photographed in other settings. The size of the transparencies and the fact that the simulation can actually be worked on over the light stages allows great precision in matching and masking.

Equipment

- overhead simulator or 4 overhead projectors
- projection surface
- transparencies of setting and proposed activities (several of each)
- acetate sheets (suitable for copy machine)
- opaque paper and paints
- transparent inks, markers, water colors, or film
- masking tape, craft knife, straight-edge ruler, scissors
- drafting pen(s)
- mounting frame (with 8½ x 10½ windows)

Simulated Scene Showing One Impact

Simulated Scene Showing Two Impacts

Computer Techniques

While simulations by computer have clearly proved their value in assessing visual impacts, one of the major constraints to using them more effectively as a *working* design tool is the time and skill required to produce them.

Clearly, some techniques are quicker than others. Very few, however, lend themselves to quick revision and rapid generation of alternatives, and the results often suffer in accuracy.

But as computers become smaller, faster, more sophisticated, less expensive, and simpler to operate, they become more accessible to a vast array of new users. A number of computer and electronic techniques are now being developed to meet the need for fast, accurate, and convenient means of examining visual impacts. The field of simulations is an example of a new field of application for computers made possible through recent advances in hardware, software, and peripheral equipment.

The following techniques represent only a few of the more widely used computer applications for simulations. Many other electronic techniques are currently being developed but have not yet seen sufficient general use to justify lengthy discussion here. (Among them are: holograms, video tape, and video disc systems.) They will undoubtedly continue to develop, however, and greatly expand the resources available for assessing visual impact.

The primary advantages of computer-generated simulations:

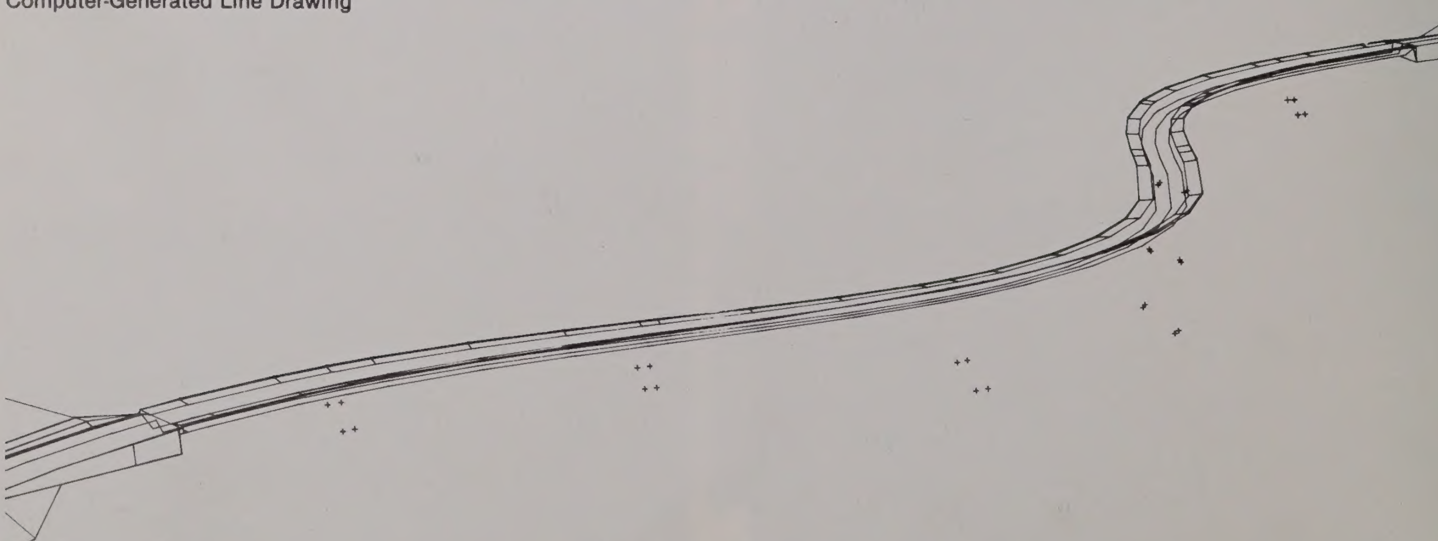
Simplicity of input Programming expertise is no longer required. Data are fed into a computer via keyboards and peripheral equipment in response to simple directions that appear on video screens.

Interaction Data can be adjusted and designs revised quite rapidly, allowing "back and forth" convergence toward an optimum solution.

Graphic capabilities Plotters, dot printers, video tape, and other peripheral hardware make it possible to produce two-dimensional (and even three-dimensional) presentations rapidly with fair accuracy. As a result, the operator's drawing skills are less important than his training in visual perception.

Proposed Site

Computer-Generated Line Drawing



Computer Perspective Montage

Definition Using a computer to generate a perspective line drawing of a specific proposed landscape change, which is mounted on a photograph of the setting. The illustrator, using any one of several rendering methods, may then enhance the simulation by painting over the line drawing.

Procedure Once oblique photographs with established ground control points have been taken of the site, trigonometric reference-point data and completed earthwork design are fed into the computer. The output is a computer-generated perspective line drawing of the proposed modifications, correctly aligned and scaled to the photograph. Control points are then matched and this drawing overlaid on the base photograph.

Enhancing the image (by showing colors, shade, cars, trees, etc.) will increase the realism of the simulation. Slides or photographs of the final rendering can then be made for audience presentations.

Time Once photographs are obtained, up to a day's work by the illustrator for artistic enhancement; potentially much longer to prepare data for the computer.

Total cost of montages can vary from $50 to $200 each.

Application This method of simulation can be extremely valuable for showing large earth-moving activities that are difficult to visualize and portray by any other technique. Enhancing the image, as described earlier, produces a realistic and accurate simulation.

A rephotographed slide greatly expands audience potential.

Additional Considerations Simulating large, earth-moving activities demands preliminary design work, since the computer program requires input in the form of earthwork design data. The final product, however, will be extremely useful in portraying alternatives which assess visual impact. The technique is limited to relatively simple landscape modifications for which earthwork design can be calculated.

Equipment

- camera, 50-mm lens (little distortion)
- oblique photos (use of airplane, if needed)
- computer and perspective plot program
- rendering materials

Composite of Proposed Site With Line Drawing

Illustrated Rendering Over Line Drawing

Desk-Top Computer Perspective Plots

Definition Desk-top computer programs that allow the simple line-drawn perspective depiction of vegetation and land modification. Three complementary visual management computer programs have been developed to date: SIGHTLINE, PERSPECTIVE PLOT and SCOPE. Essentially, the output of these programs is true-scale line drawings of: (1) seen areas (plan view), (2) landform (perspective), and (3) existing and proposed vegetation patterns (perspective) which identify ridgelines.

Procedure Landform geometry data for all three programs are obtained from a manual digital scan of topographic maps; other data are input on a keyboard. Extensive computer expertise is not necessary. All data are entered in response to questions from the computer display. Graphic results are produced mechanically on the plotter and allow the operator to evaluate and modify the plan readily. The interaction between computer and user is one of its chief advantages.

Time Up to one-half hour per original simulation, several minutes for revisions. Once equipment is set up, relatively little time is needed to input data, digitize, and receive graphic output.

Application The SIGHTLINE program outlines in plan the *seen area* from any given viewpoint, at the same scale as the topographic map.

The PERSPECTIVE PLOT program depicts activities such as timber harvesting, ski runs, roads, and utility clearings as seen from a given viewpoint or series of viewpoints. The developed areas are emphasized by drawing evenly-spaced tree figures, at correct scale, along the boundary line. Vegetation heights can be changed, and perspectives can be generated from several viewpoints.

The SCOPE program enables simulation of the *partial* removal of trees and the resultant texture modifications. It can portray terrain in a rectangular grid distorted to convey landform as seen in perspective. It can also plot a perspective depiction, with realistic randomness, of a partially cut timber stand in which trees are distributed.

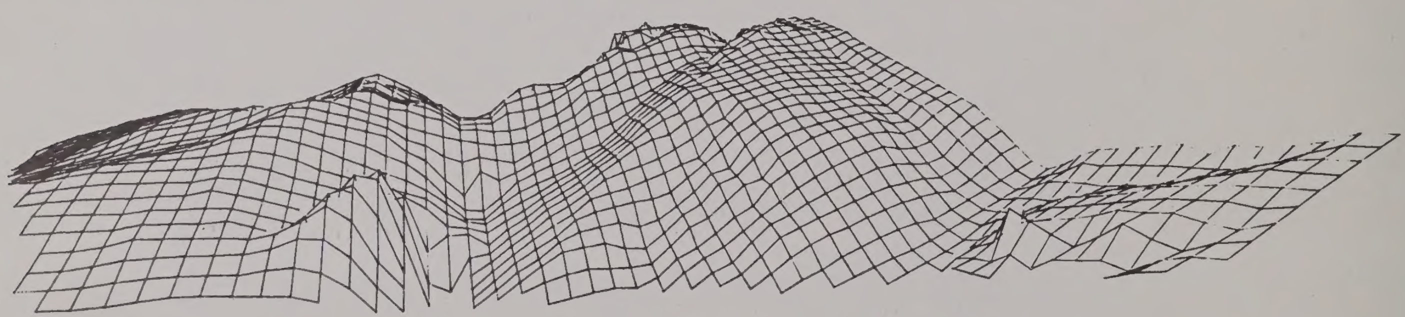
The three programs may be used individually or in concert to provide composite overlay simulations. The graphic output can be used directly in its rudimentary form, applied to a photograph as an overlay, or used as a base for artistically enhanced simulations.

Additional Considerations Complete systems range in price from $25,000 to $35,000 and are also available on a lease basis. The program software is readily available and adapts easily to several computer models.

Equipment

- a basic desk-top processing unit
- program and data storage unit
- digitizer
- printer
- plotter

Computer Perspective Printouts



Photographic Techniques

Photography has become an essential working tool in the creation of visual simulations. It can be used *directly,* as in photomontage or slide projection techniques. It can also be used *indirectly,* to record a scene that will subsequently be sketched freehand. Photography is also indispensable for public presentations and final recordings.

Photography has been made simple in recent years, but effective photography to create effective simulations can be greatly improved by adherence to several fundamental rules.

- Generally, in color-slide films, the higher the ASA (that is, the faster the film), the more the color tends to have a bluish tint. This is more pronounced in the fastest films (ASA 200 to 400) and may result in a less attractive, although not unusable, photograph.
- Faster films tend to be more "grainy," that is, images become slightly less sharp when greatly enlarged.
- Film color may vary among manufacturers even at similar ASA numbers and even among rolls of the same kind of film. These characteristics are usually most noticeable when films are juxtaposed. Therefore, the photographer should use the same film type, same speed, and the same roll, if possible, when shooting pictures that may be used in the same simulation.
- Photographs that may be juxtaposed in some way (montage, multi-projection) should be taken at similar angles and elevations (to ensure better matching of horizon lines and perspective), time of day (with consistent shadow lengths and direction), and seasons (foliage, weather).
- Shutter speeds should be 1/60th or faster to avoid camera-motion blur unless a tripod is used. From moving vehicles, 1/100th is a minimum speed to avoid vibration blurs.
- To rephotograph manual or computer simulations (usually indoors), use Tungsten 3200k film, light the object with two 3200k lamps for which the film is balanced, and follow the manufacturer's instructions. Indoor lights with regular daylight film will result in yellowish photographs. A preferred alternative: use normal film and photograph the material in direct sunlight.
- Extensive record-keeping is invaluable. When simulations or models are being photographed, particularly when experiments are being made with exposures, lights or shutter speeds, the photographer should record for each exposure the shutter speed, lens opening, camera distance, light position, film type, and date. The record should also show the camera angle for montage photography where the viewpoint in the setting and that of the image must be matched. Even a quick sketch for reference can often help a camera position be set up more accurately.
- When transparencies or slides are rephotographed from projections, a color shift often occurs between the original and the duplication. If showing a before/after comparison, both the simulation and original should be rephotographed for even color. During the summer, the deepest colors and best shadow contrasts (side lighting) occur mid-morning or late afternoon. In winter, even a mid-day sun will usually cast a long shadow. Generally, it is better to avoid photographing at times that will produce extreme shadows (long or short).

Suggested Format for Record-Keeping

	SUBJECT	DATE	TIME OF DAY	WEATHER	CAMERA ANGLE	FILM TYPE	ASA	SHUTTER SPEED	f-STOP	FILTERS
1	H.D. MODEL	9-28	10:30A	OVERCAST	V. LOW	EKTA	200	250	8	POLARIZE
2	"	"	"	"	HIGH	"	"	125	16	NONE
3										
4										
5										
6										

Selecting Viewpoints

A critical decision in any simulation is the selection of a viewpoint, the point (or points) from which the visual impact will be assessed. The key observation points are those from which activities will be most easily "seen"; those that represent the truest visual impact on the greatest number of observers. A key observation point is not necessarily the viewpoint which best characterizes the proposed project; in fact, well-designed projects will often have relatively low visibility from key observation points.

The responsible selection of key observation points requires detailed familiarity with the area and the project. Criteria which may be considered include:

Travel Routes What are the relative use levels of the major roadways, pathways, or river routes in the area? How visible is the proposed development from each route?
Recreation Uses Views from recreation areas generally need to be treated more sensitively than any others when visual impact is being evaluated. What are the existing or potential recreation use levels, what is seen, and what is the influence of season and climate?
Development Potential Is future development of key observation points likely, and, if so, how critically important is the view?
Viewing Time How long will the project be seen from a given observation point? If a project is in view for a long time, the visual impact will obviously be greater than if the viewer has only a glimpse in passing.
Seasonality of Impact At what time of year will visual impact be most evident? What focal landscapes should be evaluated?
Public Sensitivity Public concern for visual values can vary dramatically from one area to another, influenced usually by community stability, dependence on tourism, economic factors and cultural values.

Key observation points may be one, many, or sequential. Where conditions are simple, the selection may be obvious. Under other conditions, *several* viewpoints may have equal importance. In still other situations, a sequence of viewpoints may be the only way to represent true visual impact.

Several methods are available for selecting key observation points. To meet the requirements of the Bureau's VRM system, key observation points must be identified either by a manual or a computer delineation method. The manual method involves identifying from topographic and aerial maps the routes with views, inventorying the use levels of those routes from official average-daily-trip counts or visitor-days counts, then comparing these with established use-volume standards.

Computer assistance is available in the form of *seen area* computer programs. Programs such as VIEWIT and OCTVIEW have been devised to analyze terrain features and delineate areas that are visible from a single viewpoint. After key observation points have been selected, the computer can print out a map that shows the areas seen from all these points and weighs areas by cumulative visibility (number of times seen).

Using these computer programs requires a slight reversal of standard procedure. The location of the proposed activity serves as the original viewing point. The program then delineates all the areas that can be seen from that point; these, in turn, are the areas from which the activity can be seen. For example, if the activity is a coal-fired generator and the original viewing point is set at the top of its stacks, the map printout will show all the areas from which the stack can be seen. Major roadways, paths, rivers, or campgrounds that lie within these "seen areas" can easily be picked out as key observation points for simulations. Selecting other parts of the structure as additional viewing points (such as its lower, more massive elements) allows a comparison of seen areas and visual impact that may further aid in the selection of key observation points.

Once the highest-use zones have identified the key observation points, the simulation should be composed from that viewpoint regardless of the actual visibility of the activity.

Scaling Techniques

One of the most difficult tasks in any simulation is to suggest accurately the size of objects inserted into a background setting. Since simulations are generally forgiving, some inaccuracies can be tolerated without a total loss of realism. But a high level of accuracy assures the final effectiveness of the simulation.

The techniques for determining scale are numerous and quite complex. Several of the more common ones are described briefly below.

Scaled Equation Technique An object of a known size at a known distance in a photograph can be used to establish the size of other objects at that same distance.

The simplest application of this technique is to tether a helium balloon in the landscape setting at the proper location and height for the proposed activity and photograph the scene. The proposed activity can then be drawn or pasted on the photograph in its proper location and at its proper height by masking the balloon image. When the photograph is taken, if the height of the activity to be simulated is not yet known, recording the actual height of the balloon will allow correct calculations to be made on the print by the following formula:

$$\frac{\text{photo balloon height}}{\text{actual balloon height}} = \frac{\text{x (photo activity height)}}{\text{actual activity height}}$$

To establish heights for objects at other distances in the photograph requires the use of other reference data or the use of other scaling methods.

Reticle Equation Technique Marked increments (reticles) on a photograph may be used to determine the size of an object at any distance in the photograph. A base reference height such as a balloon is again required to establish height/distance relationships of the reticle markings. Once the height-to-range ratios of the reticles are known, this process allows the use of the reticles as a scale measurement for any other height/depth relationship. The process requires: (1) a reticle increment lens; (2) knowing the size of a reference object; (3) knowing distance from camera to object to be simulated. Through a series of formulas, the height of the proposed object can be determined in a dimension measurable on the face of the photograph.

Project Equation Technique The calculation of size of the object or distance of the camera may be made if one or the other is known. Trigonometric functions ("similar triangles"), known dimensions, and projector/screen dimensions are used. The formula is:

$$\frac{\text{photo image height}}{\text{actual image height}} = \frac{\text{viewer image distance}}{\text{camera object distance}}$$

Any one unknown may be derived, given information about the other three.

Perspective Technique A simple one-point perspective is integral to most simulations. To measure distance in a simulation, a simple perspective measuring grid can be constructed. From the vanishing point and horizon line, measuring planes of known height and depth are made by visual judgment of squares as seen in perspective. Once the initial judgment has been made, subsequent measuring boxes may be generated by projecting additional diagonal lines that intersect the measuring line at known intervals. In a similar fashion, horizontal measuring grids may be established to create a total measuring grid or cube on which to scale projected activities.

More complex perspective systems are also common and more accurate, especially the "two-point" perspective system.

Balloon Scaling Technique

Appendix

It is hoped that this book will provide common terms of reference for land managers, planners, and the public, and that it will become the basis for future technical advances and information exchange.

As the techniques of visual simulation are put to increasing use, sharing the lessons learned from experience will continue to be essential to the thorough and realistic assessment of visual impact.

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Although many of the references are to published works, others are not. Knowledge about visual simulations is growing at a faster pace than the published literature, so in some instances you are referred to the expert himself rather than to a published document.

The order of the references is the order of the techniques presented in the text. To help you explore some of the newer simulation techniques that are more recent and still somewhat limited, there are additional entries on holograms, stereo projection, and video tape.

If you are interested in learning more about BLM's Visual Resource Mangement Program, you may request the BLM's related publication on the VRM Program. Copies of government publications can generally be obtained by writing the specific agencies listed. You may also purchase government documents from the Superintendent of Documents, United States Government Printing Office, Washington, D.C., 20402.

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Bureau of Land Management

As the Nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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